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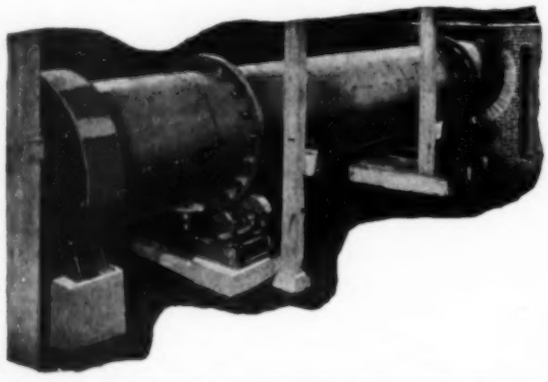

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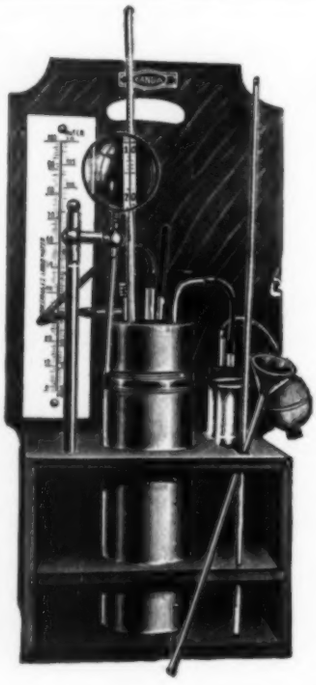

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Volume 25 — New York, September 7, 1921 — Number 10

Defenseless in War And Laggards in Peace

THE present is a historic moment in American chemistry. True, the meeting of the American Chemical Society, now in session in New York, is incidental inasmuch as it is a semi-annual occasion and the exposition is established as an annual affair. But never before was there so much at stake for chemistry in America. The reason for this is because we are momentarily weak in the weakest link of our chain.

As a nation we are a lazy people. Nearly every Yankee invention from the sulky plow to the sewing machine was designed originally to make less work and that easier. We'd rather sit down than stand up and when we search our hearts we find that most of us aspire first of all to wealth for the purpose of ease. We have let the wish become father to the thought and, having grown rich as a nation, we have, rich and poor alike, adopted luxurious habits of mind. We think hard only once in awhile; the rest of the time we let things drift until the miseries bank themselves up against us. Then we have to hustle when it is almost and sometimes quite too late. It was so with the Civil War, with the German war, with free silver, with American shipping, with the petroleum industry of which we are losing the leadership, and we are now at the parting of the ways in chemistry.

A number of signs that everyone can recognize point to this danger. The widespread devastation of research laboratories by incompetent administrators of chemical industries is one of them. Chemical industry differs from all others in that it cannot be permanently standardized. The standard of today may well spell failure tomorrow. Research must always be years—sometimes even a dozen years—ahead of the game. Unless not only administrators but even stockholders understand this, chemical industry cannot thrive.

The effort to kill the U. S. Chemical Warfare Service was another close call. We have to thank the enlightenment and the perseverance of a very few Senators and Representatives in Congress that this leading feature of national safety was not utterly destroyed. It has now been reduced to such a skeleton that only by the greatest intelligence in leadership can it be maintained. The removal of General FRIES and the appointment in succession of someone of the unscientific type of mind of General PEYTON C. MARCH, for instance, competent soldier though he may be in other respects, would destroy it in short order.

The dye industry is the bulwark of organic chemistry. Chemists and textile manufacturers and dyers and finishers all know that the price of dyes themselves has the least bearing on the cost of finished goods. They know that every dye that makes for fastness against light, wash, bleach, wear and perspiration that was available before the war is available today by direct purchase on the market or by importation under license. They know that the bulk of the costs of dyeing and finishing is in labor and time and not in dyes. And yet we find on all sides, repeated *ad nauseam*, the deliberate lie that improperly dyed goods are inferior because American-made dyes are not good. This is not true and manufacturers know it. When the coloring is inferior, it is because with the high cost of labor in American dye and finishing houses, it is cheaper to make it so. That is the sole reason. The cost of the dye itself is negligible. At the same time Congress has thrice refused to provide for the continuance within our borders of this industry, which is as essential to our national defense as the United States Artillery. If Congress does not learn this fact before the end of the year, the industry will be lost.

We could continue the enumeration of these danger signals at greater length if we were so disposed, but we shall merely add the note that the Employment Bureau of the Chemists' Club is overwhelmed with applicants for positions, whereas there are but few vacancies to fill. The applicants include men of splendid attainment and capacity. The very time when they might be doing the kind of work that reduces the cost of production or improves the quality of products they are sent away. We know of one great chemical works that let about 500 of its laborers go because there was no market for its goods. It was in the same boat as other manufacturers. But it kept its research laboratory in more intensified activity than before. "Bad times have hit us," said the president, "but we need our chemists. We need them more than we need our accountants, and we shall not close our research laboratory until after we close our office." Incidentally it may be said that the products of this plant bear an enviable reputation for quality.

Perhaps with the spread of the doctrine of relativity we may gain a larger sense of what time is. Our present disposition is to think that "any time will do." But any time will not do. We must do some things now, today, or the opportunity will pass. We must change a number of our ways. We must reorganize research by re-establishing it, not only where it has been given up but elsewhere. We must hearten the chemists engaged in their work. We must enlarge and spread chemical understanding and sense in the offices of works and among their boards of directors. We must teach our legislators the meaning of chemistry and its amazing ubiquity, from the farm to the fireside. These are our tasks today, tomorrow, next week, next month, before the year is over. We are indeed at the parting of the ways. We must conserve chemistry in America. It is the gospel of industry and the protector of nations. Without the pure science we cannot apply it and without applied chemistry we shall be defenseless in war and laggards in peace.

The Electric Furnace and Sound Castings of Pure Silver

THE introduction of the electric furnace into the United States Mint and into precious metal foundries is in itself a notable event; and it seems likely that due to the high efficiency of the operation and the excellence of its products the electric furnace will attain supremacy in this as well as in other branches of nonferrous metal melting. In changing from crucible melting to electric-furnace melting it was necessary to take into account the natural properties of silver, particularly pure silver. The latter in the molten state will occlude, absorb or combine with 22 volumes of oxygen, giving rise to the familiar phenomenon of "spitting" or "sprouting" due to the escape of the imprisoned gas as the metal cools. Whether the oxygen is combined, as MUSPRATT believed, or merely occluded has never been settled; however, metallurgists have resorted to various expedients to eliminate "sprouting," as otherwise it is impossible to make sound castings fit for rolling or stamping. Accordingly it has been common practice to use an air-tight covering of molten salt or a covering of charcoal. There are, however, serious objections to coverings of this kind.

In introducing the electric furnace into the silver foundry steps were taken to eliminate all coverings and reduce the metal losses to a minimum. The successful culmination of tests to this end are recorded by Mr. HERLENIUS elsewhere in this issue and will be presented also by Mr. DEFRIES next week. The interesting and novel feature of the work consists in the introduction of an iron block into the silver bath. This practice serves a double purpose: First, that of a heat equalizer; and second, that of an oxygen "sponge." The idea is so simple, and therefore the more valuable, that one wonders that it was not suggested long ago. But with the empirical results well in hand, it is possible to offer some thermochemical comparisons. The specific heat of iron throughout the temperature range of melting and casting silver is twice that of the precious metal. Again, the heat of combination of iron with oxygen is about ten times that of silver with oxygen. Furthermore, the iron oxides are very stable, whereas the silver oxides are very unstable.

The metallurgist may see in the principle of the iron sponge process a certain parallelism with the Parkes process of silver refining. It will be recalled that in this process advantage is taken of the fact that freezing zinc and lead are mutually insoluble, or very nearly so, while silver at the same temperature has a decided affinity for zinc and only a slight affinity for lead. Similarly, in the iron sponge process, molten silver has little affinity for iron, while oxygen has a decided affinity for iron and only a slight affinity for silver. The iron sponge process is so extremely simple and has given such excellent results in the case of silver that it seems likely the underlying principles may be applicable to the making of sound castings of other metals—for example, copper. 'Tis true that the old Lautenthal foundry used to place a wrought-iron ring on the molten silver to prevent the spattering of the silver sulphate during the Roessler refining process. Others have employed iron rods to stir the molten silver. But no one, we believe, has ever before introduced metallic iron into the molten bath, as a stabilizer of heat and an absorber of "noxious" gas. They even have told us that oxygen is insoluble in iron!

Wastes in the Iron and Steel Industry

IT IS only about twenty years ago that a steel mill was abandoned, having separate foundations for the shafts and cylinders of some of the engines. Less than thirty years ago a Corliss engine was considered far too delicate a machine to be used in a rolling mill. The industry has made wonderful progress in the past quarter century, more rapid progress than in any previous period. The best practice today is not far from the best practice it is now possible to propose. The best practice is not universal, but where it is not followed the cause is lack of capital rather than lack of knowledge or desire. There is little to criticize or suggest as to the individual manufacturing interest.

The iron and steel industry considered as a unit, however, presents cases of tremendous losses. The losses referred to are due to distributed ownership of facilities that should be under one ownership and management. One great loss is due to the existence of what are known as "merchant" blast furnaces. Another loss is due to the use of the beehive coking process instead of the byproduct process. The merchant furnaces make between 25 and 30 per cent of all the pig iron. As a rule it is not feasible for them to operate a byproduct coking plant, on account of the smallness of the operation; that is one loss. The furnace, if it has reasonably good practice, uses economically all of its gas that it needs and wastes the rest; that is another loss. A third loss arises from the furnace being idle a very considerable percentage of the time. If the steel mills, which consume between 75 and 80 per cent of all the pig iron made, should make all the pig iron, they could conveniently stock malleable, forge and foundry grades in dull times. It is disadvantageous for them to stock such iron as they use themselves, since they lose the advantage of "direct" or molten metal. With one or two interesting exceptions, all the merchant iron now made is delivered cold, so that it is iron that could readily be stocked. Steadier operation of blast furnaces would result. The recent past has given an impressive lesson of the desirability of finding an operation for steel works blast furnaces in dull times, as well as an excuse for operating attached byproduct ovens. At some steel works in the past six or eight months there has been a painful accumulation both of byproduct coke and of pig iron, partly because blast furnaces had to be operated as gas producers. The gas was needed, the pig iron was not needed.

It is a debatable question whether an economy would be represented by the steel-making industry carrying its products to a greater degree of finish. The fact that some steel makers have gone farther while others have not shows that the matter is debatable, and it is easily seen that there has been no uniformity of counsel. One steel company builds freight cars. Another, and larger, company has kept away from freight cars but makes well derricks. Another steel interest does not fabricate the sheets it rolls but does make railroad spikes. As a rule steel mills have tended to avoid fabricating their rolled products, because they wished to avoid the appearance of competition with their natural customers, but in order to "expand" have added new lines of rolled material instead of following the original line to a greater degree of finish. On the ground of economy many products could be fabricated much better by the mill than by the mill's customers.

Would the ZR-2 Have Been Saved by Helium?

SOME authorities answer this question "Yes." Some say "No." Others express a noncommittal "Perhaps." But however the question is answered, anyone who knows the facts admits that there has never been enough helium produced to have filled the ship even if all of it could have been assembled for use in the fatal trial flight.

Industrially the question of real importance is, "What is the influence upon our national helium program of this much regretted disaster? It is immaterial whether it was a failure of framework, an explosion of gas, or a gasoline fire which was the original cause of the crash. All contributed to the final result, but if helium had been present instead of hydrogen at least one element of the disaster would have been eliminated. In other words, as expressed by one Government scientist, "The disaster is another argument for the advancement of the helium program."

At present there is available for helium studies from Army appropriations a quarter-million dollars. The Navy appropriation, which is made in one general fund for several projects, will provide an additional $400,000 if it is prorated according to the original requests for funds. However, this sum can be augmented if the Secretary of the Navy should deem the helium work of greater relative importance than the other projects which must be cared for from this general fund. But it is unlikely that helium will be considered sufficiently important to increase the allotment for it to a total of $1,600,000, which is the sum requested by the Helium Board. This would practically stop other essential work in the lighter-than-air service. It seems certain, therefore, that the Government work will progress much less rapidly than was deemed desirable by the Army and Navy officials who prepared the estimates unless Congress should come to their relief.

Helium is a typically American resource. Numerous natural gas fields are known by the Bureau of Mines where recoverable quantities of helium could be obtained by a process which is already a demonstrated success in the plant at Fort Worth, Tex. No other nation has such helium reserves. Therefore, so long as helium production does not result in export, America will have exclusive advantage of this non-flammable balloon gas. Indeed, this element of exclusiveness is one of the most convincing arguments for the further development of our helium projects, expensive though they be.

It is too soon to say what the official conclusions will be on the question whether increased impetus shall be given to the helium program or not. Officials of the Army, the Navy and the Bureau of Mines all wish to reserve judgment in the matter a bit longer in the hope that we can learn more of the causes and the significance of the catastrophe. However, certain fundamental facts can be clearly set forth at once. These are most strikingly given by R. B. MOORE, chief chemist of the Bureau of Mines, who from the first has been intimately associated with the development of the helium resources and is still in charge of much of the most effective work being done by the Government in this field. He says in effect:

"For the price of one battleship it would easily be possible to maintain and operate permanently six of the most modern helium-filled dirigibles which the best talent of America could design. Included in this program would be adequate provision for reserves of helium-bearing natural gas, adequate facilities for generation of the needed helium, its recovery and repurification, and generous allowance for needed fundamental research in physics, chemistry and engineering. The question therefore is, 'Which will contribute most to American security and defense, one additional modern first-line battleship or an elaborate program in the field of non-flammable, lighter-than-air craft of wide-cruising radius, tremendous powers of offense and almost unrivaled ability in defensive observation?' "

It is too much to expect that the Government will provide thus extensively at once. The first requirement is to obtain and conserve in adequate degree the most important fields where high percentage helium-bearing natural gas is found. Fortunately this means saving gas which is generally least valuable for commercial sale, because high helium content means also high nitrogen content and low heating value. Second in importance is the support of small-scale research, particularly the work of the cryogenic laboratory at the Bureau of Mines and the corresponding activities which logically will supplement that work. In the third place, one must then ask for plant-scale research, including perhaps the necessary investigations to make the Petrolia plant using the Jeffreys-Norton process a success, if this proves feasible. Next will be the provision for plant operation on a large scale and large-capacity storage of the gas. Finally will come the time when construction of the several airships for use with helium can be undertaken with the surety that adequate supply of gas will be at hand for their regular operation. In the meantime, of course, much work on design of these vessels and a limited amount of experimentation on their construction would be expected. Unfortunately progress on this extensive program is likely to be slower than all of us would wish, but so long as definite progress is constantly being made, and along right lines, every encouragement should be given to the Government in its helium projects. That the progress will be along the right lines seems assured, for Army, Navy and scientific bureau specialists are co-operating closely through the Helium Board and no chance for constructive criticism and advice is being ignored by any of these agencies.

And AGAIN, What Is a Chemist?

THE question will not down, and sometimes out of the mouths of babes and sucklings come—sidelights. In the New York office of a large heavy chemical manufacturing concern there is a lad of fourteen who shows originality, although it is scarcely of the type that indicates the possession of the research mind. One morning not long ago he appeared with great, horn-rimmed spectacles. He was asked if he was having trouble with his eyes, and he replied that he was not. "I am studying," he explained, "to be an acid expert."

If we are "very much what we think we are," then this cheerful youngster is doubtless already "very much" of an acid expert. And yet even this does not fully answer a question which has been teasing us for a considerable time and to which we can get no satisfactory answer. It has become a chronic conundrum. Why can we not get general trade specifications for heavy chemicals? Every effort thus far has been unsuccessful.

Readers' Views and Comments

The Constitution of Gas Atmospheres in Aluminum Alloy Melting Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 60 of your issue of July 13, 1921, in an article by Robert J. Anderson and J. H. Capps, entitled "The Constitution of Gas Atmospheres in Aluminum Alloy Melting Furnaces," there appears some discussion with regard to the toxicity of gases emanating from electric furnaces used for this purpose.

Carbon monoxide is, of course, extremely poisonous, and if all of the carbon monoxide produced in such a furnace were to be discharged unchanged into the foundry atmosphere, a serious condition would probably result. As a matter of fact, such carbon monoxide as does leave the furnace through various vents is at an extremely high temperature in the case of arc furnaces particularly and, as a result, burns to carbon dioxide as soon as it strikes the air. This is obvious to anyone who has watched the operation of an electric arc furnace for any length of time, whether this furnace is melting steel, brass, aluminum or any other metal whatsoever. I believe that any user of electric arc furnaces will agree that it is practically impossible for any appreciable amount of carbon monoxide to escape from his furnaces into the atmosphere of the foundry.

With respect to cyanogen the situation is, of course, somewhat different, but the authors state in this same article that they have been unable to detect cyanogen by chemical methods even in the atmosphere of the furnace itself where it would be most concentrated. Although it is occasionally possible to detect the odor of cyanogen in the neighborhood of an electric furnace melting aluminum, this gas is evidently present in such exceedingly small quantities that no unpleasant results are to be expected. As a matter of fact, as the authors state, there is absolutely no record of injury to health from electric-furnace gases in any commercial installation despite the fact that electric furnaces have been in use for many years in the melting of both steel and brass.

H. M. ST. JOHN,
Service Manager.

Detroit, Mich.

Culture in Technical Education

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your editorial on "Culture in Technical Education" in the number for July 20 overlooks one important element in the problem under consideration. At the end of any four-year course the father of the boy taking it has had frequent reminders of the fact that college courses are expensive. In very many cases the family resources have been strained by reason of this. To add two more years to the total would in not a few cases make such a course impossible for some of the best men applying. I think this has had much to do with the present condition of things, and I know of one case where this was the controlling thought.

Given a student who has enough perseverance to give six years to such a quest, there can be no doubt that six years are better than four. It seems to me, however, that it may be worth consideration whether some of the additional courses desired may not come into the college preparatory course. I cannot rid myself of the impression that too much of the pre-college time is poorly applied, and, in some instances, almost entirely wasted.

It is also true that much time in college is wasted. Not a few college professors are extremely poor teachers; in some cases men remarkable for work as investigators have shown an utter lack of teaching ability. I have come to think that college professors should be classified as teachers and investigators, and that the first class should be required to take normal school courses before teaching. Some college professors I have known have failed to understand that there is such a thing as psychology. The appeal to reason is their only appeal, and this is very seldom effective.

EDWARD HART.

Lafayette College,
Easton, Pa.

Studies in Colorado Shale Oils

To the Editor of Chemical and Metallurgical Engineering

SIR:—In reading the interesting article by A. J. Franks, in your July 13th number, on "Studies in Colorado Shale Oils," we were rather surprised that after he had discontinued the use of the cumbersome Waters method for the determination of sulphur in his samples of shale oil, he turned to the use of the Parr sodium peroxide bomb.

In Technical Paper 26 of the Bureau of Mines the results of an investigation of the various methods of sulphur determination of oils are shown. The Bureau went into this matter very carefully and they found that the use of an oxygen bomb gave a method for sulphur determination of oils and combustible materials which was "accurate, rapid and reliable."

The Parr oxygen bomb, made of the so-called illium alloy, is particularly adapted to this work and if one does not care to secure the bomb manufactured for the calorific determinations, there is a smaller size which is turned out especially for sulphur determinations.

We believe that Mr. Franks would have saved himself considerable work and time had he used an oxygen bomb for his sulphur determinations.

RALPH R. MATTHEWS.

Roxana Petroleum Corporation,
Wood River, Ill.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reply to Mr. Matthews' comment I wish to bring to his attention the fourth and eighth paragraphs of my paper, in which he will find, among other relevant statements, the following sentences: "Since it is beyond the scope of this paper to discuss the relative merits and defects of different methods for determining sulphur, only the two which were actually tried will be given consideration." "Since a complete discourse on this subject would be too long to be included here, only the main points will be considered briefly, a fuller and more detailed discussion being reserved for a later paper."

My paper dealt primarily with the amounts of sulphur in shale oils and their fractions, not with methods for determining sulphur. A comprehensive discussion

of the latter subject would have required much valuable space. Such a discourse could not have been justly included. I reserved it for a later paper which has been in preparation for some time. Hence I did not choose to present all the data I had, nor any but very general and brief reasons for adopting the sodium peroxide fusion method. Under these circumstances I do not feel that anyone is justified in making critical suggestions or remarks concerning the methods I used. It is entirely sufficient that the results given in my paper are accurate.

Mr. Matthews' letter conveys the impression that I am not aware of the fact that there is such an apparatus as the Parr oxygen bomb for sulphur determinations and that there are advantages attending its use. I can say with pride that I am a former pupil of Prof. Parr, and am very well acquainted with the virtues of all standard apparatus of his design.

Although I expect later to discuss the subject in detail in a special paper, I will defend my choice with a few brief remarks, since the wisdom of my decision has been questioned. Permit me to repeat the requirements which a method must meet in order to serve satisfactorily for the large number of determinations which we were called upon to make in the course of our research:

1. The cost of the apparatus should not be great.
2. The results must be dependable and as accurate as possible.
3. The determinations should require a minimum amount of time.

If analyses are to be made economically, at least two bombs are required. The cost of a single oxygen bomb and the necessary accessories is far in excess of that for two peroxide bombs. Hence where expense is a factor the use of the former is out of the question.

In so far as accuracy is concerned the peroxide bomb method is superior or at least equal to the oxygen bomb. As evidence of the truth of this contention and the lack of agreement between three series of determinations made with the latter instrument by reputable laboratories on three oils, C. E. Waters (U. S. Bureau of Standards Tech. Paper 177) presents these data:

	Per Cent Sulphur
Mexican oil	1.52 to 1.90
Red oil	0.39 to 0.53
Vulcanized oil	0.89 to 1.22

He also states: "One laboratory alone reported five determinations on the red oil which ranged from 0.42 to 0.53 per cent, while eight results for the vulcanized oil varied from 0.89 to 1.19 per cent." There are differences of 20 to 27 per cent between the above results for the same oil. Differences between results reported in my paper seldom exceed 1 or 2 per cent. Since accuracy is the chief consideration in such research, there is no occasion for criticism because of the time element.

But let the question of accuracy and expense be neglected for a moment and only the factor of time be considered. In spite of Mr. Matthews' opinion to the contrary, the peroxide fusion method does not require more time and energy than the oxygen bomb method. It is at least as rapid as if not more rapid than the latter, and is less awkward. The peroxide bomb can be charged, closed, ignited, cooled and the contents removed with greater speed and ease than can the oxygen bomb. From here on the operations are practically identical in each case. If the oxygen bomb is equipped with a lead gasket, an additional quarter to half an hour will be required to convert any lead sulphate, which might have been formed, to soluble sulphate. Where then does the saving of time come in through the use of the oxygen bomb? Since it is more expensive than the peroxide bomb and the results it gives are no more accurate than the peroxide bomb, I fail to recognize Mr. Matthews' suggestion as being either useful or illuminating.

ARTHUR J. FRANKS.

Department of Chemistry,
Colorado School of Mines,
Golden, Col.

Multiple Effect Evaporation

To the Editor of Chemical & Metallurgical Engineering

SIR:—On pages 110 to 115 of your number of July 20, 1921, appeared an article by Burton Dunglinson, entitled "Multiple Effect Evaporation." There are certain statements in this article which Mr. Dunglinson apparently gives without careful study or knowledge of the subject, and we would therefore ask you kindly to make the following corrections:

No Kestner evaporator up to 12,000 sq.ft. heating surface per body built in this country or to our knowledge in Europe has ever developed any "mechanical difficulties such as sagging of the tube due to its weight and consequent strain of the top tube plate with the result that leaks will develop."

The extremely large time of contact in the 20-ft. or rather 23-ft. Kestner tube does not exceed one-half the time the liquid is in contact with the Multiplex tube.

The average scouring effect produced in the Kestner tube due to the velocities is at least four times greater than that in the Multiplex tube.

The limiting height of the Kestner evaporator is the same as that of the Multiplex—namely, the height of a barometric condenser.

The floor space required for Kestners of such small sizes as the superimposed Multiplex is adapted to depends upon the space required for the auxiliaries, and in a Kestner installation is, therefore, no greater than in a similar sized Multiplex. In the larger sizes the Kestner evaporator requires less floor space than does the Multiplex, owing to the necessarily larger diameter steam belts in the shorter tube Multiplex body.

In fact, not one of the claims of superiority advanced for the Multiplex as an improvement in the art, but is equaled or surpassed by the older Kestner type.

KESTNER EVAPORATOR CO.,
RALPH MELLOR, President.

Philadelphia, Pa.

More on the Tellurides and Selenides

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring further to the subject of selenides and tellurides, concerning which I published a short note in your issue of Aug. 17, the sodium and potassium compounds are also interesting.

I first ran into these in an ill-advised attempt to produce metallic tellurium by direct reduction of the oxide, using sodium carbonate as a flux. The result was sodium telluride. The compound gives a beautiful solution if kept away from air, the color being very like that of potassium permanganate. Both the selenide and telluride decompose very readily from the oxygen of the air setting free metallic tellurium and metallic selenium with formation of sodium hydroxide. I believe that this reaction was made the basis by A. E. Knorr of a process for the recovery of these metals.

New York City. DONALD M. LIDDELL.

Electric Furnaces for Silver, Gold and Metals of Low Melting Point

Points to Be Considered in the Electric Melting of Silver, Gold and Metals of Low Pouring Temperature and Their Alloys — Selection of Appropriate Furnaces — Results Obtained

By JONAS HERLENIUS

FOR many reasons the use of electric furnaces has lately been widely extended and will eventually include every industry, as soon as electric current is available at a reasonable price. Practically every known method of generating heat electrically has been utilized in the electric furnace art and it should therefore seem possible to select the proper furnace suitable for a particular purpose. The choice of furnace, however, requires a study of all the details connected with each individual melting problem in order to decide upon the type that will, as much as possible, answer all requirements.

Undeveloped Field for Electric Furnaces

For the refining of steel and the melting of copper, nickel, aluminum, brass and bronze the electric furnace is now in use so extensively that the prospective user has a large field for practical investigation. Furthermore, there is ample literature available covering operating conditions, together with accurate figures on the results obtained. However, in the melting of some other metals, notably silver, gold, lead, zinc and tin, the electric furnace is in only limited use and for certain reasons its introduction is progressing very slowly. It should be only a question of time, nevertheless, until the merits of using electric furnaces for these metals will also be fully recognized, as it requires a type of work where the electric process is distinctly adaptable. Secrecy and limited use are the contributing reasons why so very little as yet has been published concerning the results obtained and other operating data from furnaces melting these metals. It must also be borne in mind that the part of this article dealing with the possibilities of electric furnaces in this new field is based on conclusions drawn from theoretical calculations or from the comparison of analagous conditions which occur during the melting of other metals.

Advantages in the Use of Electric Furnaces

The electric furnace has the following main advantages over fuel-heated furnaces:

1. A more perfect temperature control.
2. Less loss by oxidation due to a neutral or reducing atmosphere.
3. A higher efficiency.

These three points are of such importance that it may safely be expected that any heating problem will ultimately be handled electrically when adequate furnace types have been developed. The prevailing high price of current in many districts, however, has greatly hampered the introduction of electric furnaces, mainly because the prospective user fails to understand that an eventual increase of his fuel cost will generally be fully offset by a better quality of the product and by a higher efficiency of the melting equipment.

According to the method of heat generation, electric furnaces may be divided into the following main classifications:

1. Direct arcing furnaces, where the heat is generated in arcs between electrodes and the material charged, using it as a part of the circuit.
2. Free-burning arc furnaces, where the heat is generated independently of the charge, in arcs drawn between the tips of electrodes located above the metal.
3. Carbon resistor furnaces having special heating units located along the sides of the hearth, from which the heat is radiated to the charge, either directly or reverberated.
4. Induction furnaces, where the heat is generated in the metal itself by induction from primary coils suitably located; the furnace being constructed so that the metal charge forms a secondary closed circuit.
5. High-frequency induction furnaces, where the heat is generated in the metal charge or its container by eddy currents induced by current coils surrounding the crucible.
6. Wire-resistance furnaces, having special heating units in the form of wire coils located outside of the crucible containing the metal, from which the heat is conducted through the crucible wall.

The first class—i.e., direct arcing furnaces—which have found such extensive use in the melting and refining of steel, are not suitable for metals with low melting points. An excessive loss by volatilization is inevitable on account of the high temperature developed by the arcs in direct contact with the charge. This group of furnaces for that reason will not be considered here, while all the other furnace types will show important applications.

Points to Be Considered in the Melting of Silver

Silver has a melting point of about 1,760 deg. F. (about 960 deg. C.), has no low volatile oxide and can therefore be exposed to the air even at high temperatures without any danger of loss through oxidation. Silver, however, in the molten stage has the property of absorbing gases, especially oxygen, to a large extent. These gases are partly liberated on cooling, but partly retained in solid solution, giving rise to brittleness rendering the metal unfit for rolling. It is therefore necessary to exclude all air draught to avoid agitation of the metal, and to maintain a slightly reducing atmosphere in any furnace used for silver melting.

The boiling point of silver is about 3,550 deg. F. (about 1,950 deg. C.); some volatilization is supposed to occur at about its melting temperature. The loss

by volatilization is, however, very small as long as the liquid metal is not superheated to any great extent, but electric arcs close to or in direct contact with the metal are out of the question.

The pouring temperature of sterling or fine silver should be from 2,360 to 2,380 deg. F. (about 1,295 to 1,305 deg. C.), and if possible further superheating should be avoided. In pouring at a higher or lower temperature the metal is apt to crystallize coarsely upon solidifying, making it extremely brittle. An accurate temperature control in the furnace is therefore highly desirable in order properly to regulate the pouring temperature.

Any sudden chill in handling the molten metal, as for instance an excessive loss of time in transporting it from the furnace to the molds, will cause brittleness. For this reason lip-tilting type furnaces will best answer the purpose and usually specially designed pivoted pouring spoons are attached directly underneath the spout. The molds are located in front of this spoon to permit direct pouring, and care should be taken to preheat the spoon to incandescent heat and have it closed by a suitable cover.

Another important feature in silver melting is to prevent as much as possible the absorption of the metal in the lining. If crucibles are not used, the bottom should be tamped in with utmost care, using gannister or a suitable mixture of carborundum and fireclay. The rest of the furnace should be lined with either silica or a good grade of firebrick.

To summarize what is stated above, the following features are essential for a furnace to be employed in the melting of silver:

1. The furnace should produce enough heat in order that a sufficiently high pouring temperature may easily be reached and a quick melting down accomplished.
2. A proper application of the heat developed in the furnace must be provided for to avoid excessive local superheating and consequent loss by volatilization.
3. An efficient temperature control of the furnace is essential in order that the charge may be poured at the proper temperature and thereby avoid brittleness of the metal.
4. The furnace must be tight so as to exclude any air draught.
5. A suitable working door should be provided to allow for the introduction of slag-building material and to be able to work or stir the metal if necessary.
6. The furnace should be of the tilting type, preferably lip-tilted, to assure quick and efficient pouring.

Various Types of Furnaces Used for Melting Silver

The Rennerfelt electric furnace, which is of the free-burning arc type, has been employed extensively for melting silver both in this country and abroad and seems to be especially adaptable for this purpose.

At the U. S. Mint in Philadelphia a 1,000-lb. capacity furnace operated continuously for several months, remelting 3,142,000 lb. of silver dollars into bullion. This furnace was taking off about twenty-two heats per twenty-four hours, with an average power consumption of 177 kw.-hr. per net ton. The total loss amounted to 0.75 oz. per 1,000 oz. and was due partly to volatilization, but mainly to absorption of metal by the lining, which later was recovered. The net loss after deducting the recovery was approximately 0.20 oz. per 1,000 oz. The actual melting time for a 1,000-lb. heat was fifty minutes.

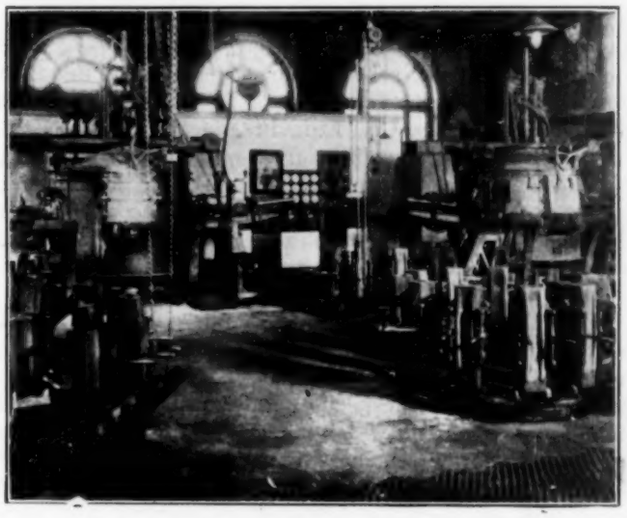

FIG. 1. RENNERFELT ELECTRIC FURNACE INSTALLATION AT U. S. MINT, PHILADELPHIA, PA.

This furnace has a 150-kva., 40 deg. C. transformer bank, and is equipped with a two-electrode General Electric automatic electrode control. It is of the lip-tilting type and is tilted by means of a small 1½-hp. electric motor.

At another plant a 500-lb, 100-kva. Rennerfelt furnace is in operation on sterling and fine silver. This furnace is turning out about one heat per hour, with an actual power consumption of 250 kw.-hr. per net ton and an additional 80 kw.-hr. for preheating the furnace in the morning. The melting loss is practically negligible and amounts to only 4 oz. per heat of 5,000 troy ounces.

In practice the Rennerfelt furnace is preheated to at least a light yellow incandescent heat before charging the silver. After the metal is melted some powdered charcoal is generally scattered all over the bath and a slightly reducing atmosphere is maintained in the furnace. Too much charcoal, however, has been found injurious. With the metal there is often charged a small piece of wrought iron, which in practice seems to have very important advantages. The iron serves as a heat equalizer and furthermore will absorb to a great extent the oxygen present in the liquid silver.

Usually no slag building material is required except when it is necessary to remove zinc when the metal is slightly contaminated by german silver. An aluminum silicate slag is then built up of fireclay, which will bind the zinc as ZnO, although part of the metal will be eliminated in volatilization during melting down.

In order to ascertain the pouring temperature, spoon tests are generally taken from the furnace and poured into water. If the metal sticks to the spoon, it is far too cold, and a sufficient temperature is not reached until the silver granulates in the water and the spoon empties clean.

The variation in operating results with the Rennerfelt furnaces referred to is due to difference in practice and capacity and to the quality of the metal melted. The silver dollars are only remelted into bullion and the pouring temperature is therefore considerably lower than is otherwise required; this accounts for the lower power consumption.

In the furnace melting sterling and fine silver utmost care must be exercised in order to obtain sound castings and to make the metal fit for rolling and stamping.

This necessitates a considerably higher pouring temperature.

Only one carbon resistor furnace has been installed for the melting of silver—i.e., a Baily furnace at the William A. Rogers Co., Ltd., in Niagara Falls, N. Y. This is a pit type crucible furnace, used for recovering the silver from the company's electrolytic process for plating. The furnace is rated 30 kw. and accommodates two crucibles holding approximately 500 oz. each. These crucibles are lifted out for pouring; the metal is cast into anodes.

This Baily furnace has been in operation since 1914 and has given very satisfactory results in comparison with the oil furnace previously used. A great improvement was obtained especially in uniform heating and temperature control, which made it possible to pour the silver at a lower temperature and still obtain a more homogeneous metal. A slow, soaking, well-distributed heat and an accurate temperature control are very important advantages of the Baily furnace, which account for its great success in various metallurgical fields.

The pouring temperature of the metal melted at the Rogers company is estimated to be about 2,200 deg. F., although no pyrometer is used. This temperature is sufficiently high for a fluid metal when no complicated castings are poured or when the silver does not have to be rolled. Eight heats per day of 1,000 oz. each were poured with practically no loss. The average time for charging, pouring and melting of one heat was about one hour and seven minutes.

The power consumption with this furnace, however, was very high in comparison with other furnaces herein described. This, of course, is due to the fact that the metal is heated indirectly in crucibles.

It is a question whether it would not be more practical, especially in larger scale production, to melt the silver in the Baily furnace directly on the hearth instead of in crucibles. The excellent results obtained with free-burning arc furnaces in silver melting tend to indicate that it ought to be feasible, even if the metal loss increased slightly.

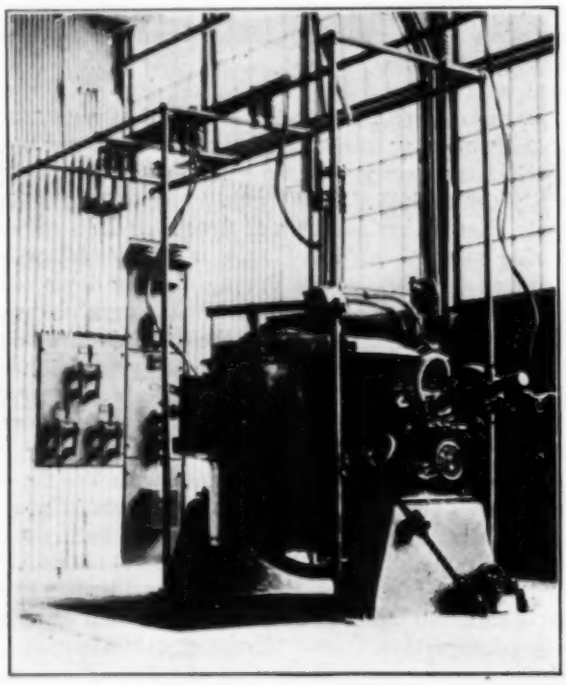

FIG. 2. RENNERFELT ELECTRIC ARC FURNACE, STANDARD 500-LB. TYPE

Other carbon resistor furnaces, for instance the General Electric and the electric reverberatory types, will surely melt silver commercially either directly on the hearth or in crucibles similar to the Baily type used by the Rogers company. It is a fact, however, that the efficiency of all furnaces built on the principle of radiated resistor heat will be considerably less than for direct arcing types. Whether the employment of crucibles will compare favorably with open-hearth melting, due to lower metal loss and improved quality of the castings, can be determined only after further trials on a larger scale.

The ordinary horizontal ring induction furnace is not suitable for silver melting, because of "pinch" troubles due to the high electrical conductivity of the metal. Even the vertical ring induction furnace—for example, the Ajax-Wyatt—although used extensively in brass foundries, has not proved to be a successful type for silver melting. It is true that in this furnace the hydrostatic head of the molten metal will oppose the "pinch" force, but silver has so high an electrical conductivity that the efficiency of the furnace is considerably decreased. All induction furnaces, furthermore, require continuous operation or a liquid charge for starting, which naturally is a distinct objection in the handling of any precious metal, since the silver melting plants usually operate on but one shift.

High-Frequency Furnaces

The only high-frequency induction furnace on the market is the Ajax-Northrup type, which is manufactured in sizes up to 60 kw. power rating. Four of these furnaces are in operation at the U. S. Mint in Philadelphia for coinage silver and one at the plant of Handy & Harmon in Bridgeport, Conn., for sterling silver. The results obtained have been very gratifying. For this reason its operating conditions will be described in detail.

As stated above, silver has too high electrical conductivity to be melted with any satisfactory efficiency by direct induction. In order to overcome this obstacle, the Ajax-Northrup furnace is equipped with a crucible of molded carbon or graphite to replace or to fit into the crucible of non-conducting refractory material usually supplied. The heat is thus generated in the walls of this carbon crucible and transmitted to the metal contained by conduction or radiation.

The furnaces installed at the U. S. Mint in Philadelphia, Pa., are stationary, single-phase units, specially constructed to answer local conditions and to change the existing practice as little as possible. Two of these furnaces have been in operation for over one year on fine silver and gold for rolling and stamping. They have a power rating of 8 kw. each and hold two small crucibles, which are lifted from the furnace and poured. The two other furnaces are rated 16 kw. and accommodate one crucible each, from which the silver is dipped or ladled out until about 200 oz. remain, which are removed by withdrawing the crucible and pouring it out. Recently either one of the larger furnaces is operated two-phase, using 32 kw. power input, which corresponds to the total power that was originally intended for both units. This has considerably increased the efficiency and the two furnaces are now run alternately twenty-four hours.

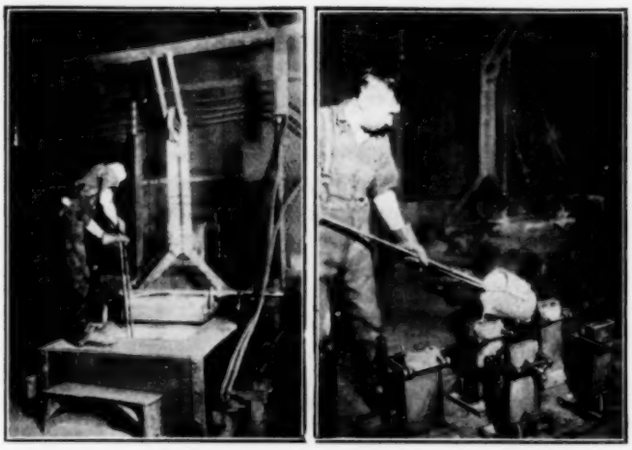

FIG. 3. BAILY PIT TYPE ELECTRIC CRUCIBLE FURNACE AT WM. A. ROGERS CO., NIAGARA FALLS, N. Y.

In a trial run with one of the larger furnaces at the U. S. Mint four charges, constituting 13,490 oz., were melted in seven hours' time, with a power consumption of 156.5 kw.-hr. This is equal to 5.9 lb. per kw.-hr., or 340 kw.-hr. per net ton. The average load was 12½ kw. per phase, or a total of 25 kw., and the metal loss was almost negligible.

The furnace at Handy & Harmon's is lip-tilted and pours directly into the molds without intermediate ladles or pouring spoons. It is a three-phase installation, which absorbs 60 kw. from the supply line, 30 to 40 per cent of which is lost in the high-frequency converter. This makes an actual power rating of the furnace crucible of about 40 kw.

The furnace has a capacity of about 600 lb. of silver per melt. One day's operation shows a production of 36,558.50 oz. of sterling silver melted in eight hours and fifteen minutes, including preheating, and uses about 317 kw.-hr. This makes an average of 7.95 lb. of silver per kw.-hr. for the entire time consumed, or a power consumption of approximately 252 kw.-hr. per net ton.

The Ajax-Northrup furnace consequently shows remarkable efficiency in the melting of silver and in case the mechanical defects are overcome, this furnace should answer most of the requirements for silver melting on a smaller scale. The life of the conducting crucible will have to be established from further trials and there still remains the question as to whether this part of the furnace will meet all requirements in general commercial operation. A distinct advantage of this high-frequency type is that in melting in a closed crucible the metal is prevented practically from absorbing any gases. On the other hand, the removal of zinc, in case the silver is contaminated by german silver, is not possible. The practice of inserting a piece of iron into the metal bath of this furnace would materially disturb the induction. There is less need for a deoxidizer, however, and no heat equalizer is required in a furnace where the heat distribution is so nearly perfect.

Wire-resistance furnaces do not produce sufficient heat to melt silver and are consequently not applicable.

Points to Be Considered in the Melting of Gold

Gold is always alloyed to a certain extent with some other metal, especially copper, silver or platinum. It has a melting point of about 1,950 deg. F. (about 1,065 deg. C.), begins to volatilize around 2,010 deg. F. (about 1,100 deg. C.) and volatilizes four times as fast at 2,280 deg. F. (about 1,250 deg. C.). The pouring temperature should therefore be slightly above its melting point and excessive superheating must be carefully avoided in order to prevent any loss by volatilization of this precious metal.

Gold should only be melted in crucibles and the main requirements of a suitable furnace are an accurate temperature control and a uniform heat distribution. Gold is so expensive that low loss handling is paramount, while the efficiency of the melting equipment ranks next in importance, but does not have the same bearing from the standpoint of economy.

Arc furnaces are not suitable for heating crucibles, on account of insufficient temperature control and subsequent danger of superheating. Carbon resistor furnaces may be applicable and especially the previously described Baily pit furnace used at the William A. Rogers Co., Ltd. This type has a slow, soaking heat and possesses excellent means for an accurate temperature control.

Other furnaces belonging to the same group, especially the General Electric and the electric reverberatory types, could probably be adapted if constructed for the purpose. Thus far, however, no furnaces of these types have been employed for melting this metal.

Gold has too high electrical conductivity to be melted by direct induction. Such furnaces are consequently not suitable, with the exception of the Ajax-Northrup, where a conductive crucible is used as described under silver melting. Some small furnaces of this type have been installed for gold melting, using a graphite crucible, and the performances have been very satisfactory. In a 6-in. crucible with a net volume of 53 cu.in. 37 lb. of gold can be melted in eight minutes at a rate of 14 lb. per kw.-hr. consumed. The crucible is coated with a special refractory material which will cohere to the graphite and withstand a high temperature in order to prevent the crucible from being oxidized by the air.[1]

If the gold is alloyed with platinum, a metal which has a very high resistivity, the resultant electrical

[1]See CHEM. & MET. ENG., June 22, 1921. Footnote on p. 1099.

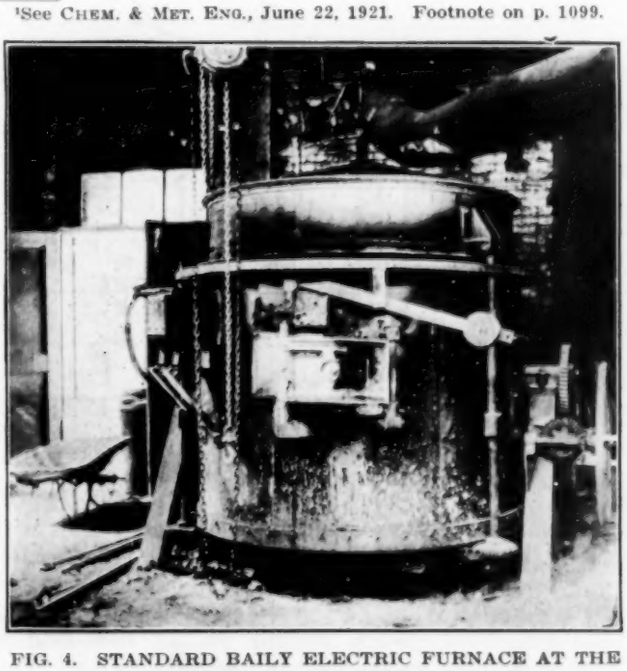

FIG. 4. STANDARD BAILY ELECTRIC FURNACE AT THE LUMEN BEARING CO., BUFFALO, N. Y.

conductivity may be decreased sufficiently so that the alloy can be melted by direct induction in a clay or magnesite crucible. This is of great importance in the melting of gold-platinum alloys, due to the fact that any contamination by carbon is to be avoided and a more homogeneous metal can be produced, due to the stirring action caused by the currents induced in the bath.

In a test recently carried out 50 troy ounces of an alloy containing 85 per cent fine gold and 15 per cent pure platinum were melted in a No. 5 clay crucible which was washed inside with electrically sintered magnesia. In six minutes the charge was melted and considered sufficiently fluid for pouring. The ingot cast was rolled out and found to be free from platinum streaks, which frequently appear when using gas- or oil-fired crucibles.

There are many reasons why the high-frequency induction furnace may be considered particularly well adapted for melting gold and platinum. It enables the melting of very small quantities of metal with comparatively high efficiency. The furnace also possesses an accurate temperature control and a uniform, well-distributed heat. Furthermore, the stirring action which is an inherent feature with direct induction furnaces is an important advantage in alloying gold and platinum.

Points to Be Considered in the Melting of Zinc, Tin and Lead

When melting metals of very low pouring temperature, only such furnaces should be employed as possess either suitable means for accurate low-temperature control or where the source of heat is limited to a certain temperature equilibrium. This concerns practically all metals or alloys that melt below 1,000 deg. F. (540 deg. C.) and include zinc, tin and lead and their alloys

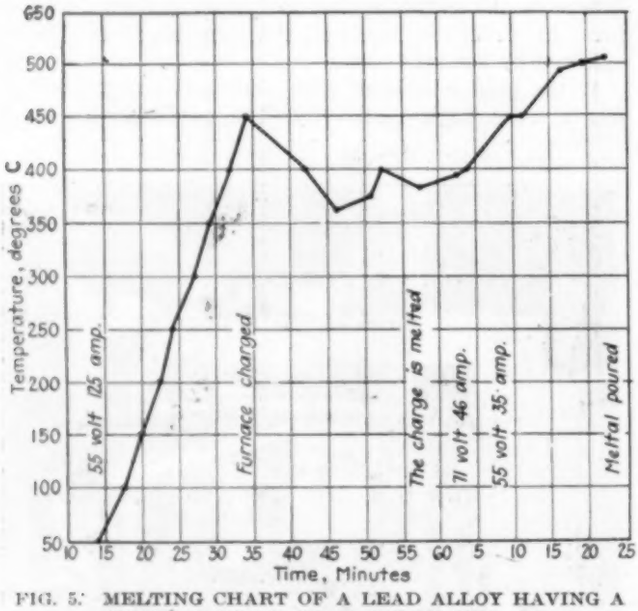

FIG. 5. MELTING CHART OF A LEAD ALLOY HAVING A MELTING POINT OF ABOUT 370 DEG. C.

and certain other important alloys of these metals with copper, bismuth, antimony and cadmium. It is feasible to melt any of these metals or alloys electrically if adequate furnace types are employed, and a very rapid development of electric melting in this new field of metallurgy may be expected in the near future. This is a very comprehensive subject, however, and the limits of this article preclude any detailed account.

All arc furnaces produce too much heat and are therefore not suitable for metals of low melting point.

Resistance radiating furnaces have a close temperature control and should therefore be well suited under certain conditions. For large-scale production, demanding furnaces in tonnage capacities, this type is so far the only one available. One Baily furnace is in operation at the Lumen Bearing Co., in Buffalo, N. Y., melting "Lumen" metal, which is an alloy of 85 per cent Zn, 10 per cent Cu and 5 per cent Al. It is a 105-kw. tilting type furnace of 1,000-lb. capacity producing about one heat per hour, with a power consumption of from 200 to 240 kw.-hr. per net ton. The metal is poured at a temperature of about 1,300 deg. F. (about 705 deg. C.), and the metal loss varies between 2½ and 3½ per cent.

As all these metals have rather low electrical conductivity, it should be possible to melt with direct induction, in case 24-hr. operation can be established and the composition of the alloy is not changed too frequently. The high thermal efficiency and the circulation in the metal bath are features of great advantage with this type of furnace.

The Ajax-Northrup high-frequency induction furnace employs an iron crucible as a container for lower melting metals and alloys. The heat is developed in the iron by induction, which can be done with high efficiency and almost perfect temperature control. Using a 10-in. crucible, 25 lb. of zinc can be melted in six minutes at a rate of 13 lb. per kw.-hr.; 25 lb. of tin and 39 lb. of lead are melted in two and one-half minutes at the rate of 30 and 50 lb. per kw.-hr. respectively.

Wire-resistance furnaces are very well qualified for any kind of low-temperature work, because the temperature is under perfect control by changing the connection of a number of the heating elements surrounding the crucible. The heat input is furthermore limited so that excessive superheating is rendered impossible, and after the desired temperature is reached by adjusting the power input this temperature is maintained by a constant heat supply. The furnace works slowly but with comparatively high efficiency and is particularly well adapted when it is desired to keep a metal liquid at a constant temperature for a long time. This principle of electric heating should therefore be used to advantage in heating soldering pots, lead baths for annealing purposes, melting stereotype metal, etc. A series of trial runs with a small furnace of this type have been submitted by Hamilton & Hansell, Inc. The variation in temperatures in one of these runs is represented by the curve shown (Fig. 5) and refers to a lead alloy having a melting point of about 700 deg. F. (about 370 deg. C.).

The furnace was preheated empty to about 840 deg. F. (about 450 deg. C.) in twenty minutes, using about 2½ kw.-hr. and afterward charged with 176 lb. of lead. The metal was melted in twenty-five minutes, superheated in an additional twenty-five minutes and poured at about 960 deg. F. (about 515 deg. C.). The average power input was about 55 volt, 125 amp. d.c. or 6.9 kw. The total consumption of power was 6½ kw.-hr., of which 4 kw.-hr. was actually consumed for melting. This is equal to 27 lb. of metal per kw.-hr. covering all the time used, or 44 lb. per kw.-hr. excluding the preheating.

Studies in Evaporator Design—V

Experimental Data for Horizontal Tube Evaporator Showing Relation Between Hydrostatic Head, Temperature Drop and Heat Transmission—Ratio of Corrected Coefficients for Two Different Temperature Drops Is Constant for All Levels*

BY W. L. BADGER

THIS paper presents two curves showing the relation between hydrostatic head and heat transmission in a horizontal tube evaporator. These two curves were determined at the same boiling point, but with a different steam temperature for each curve; thereby furnishing means for determining the relation between hydrostatic head, temperature drop and heat transmission.

So far as the writer has been able to determine, no systematic experimental work has been done on horizontal tube evaporators. There are scattered tests of horizontal tube evaporators available, but they are all reports of isolated tests on evaporators in actual plant operation, and are therefore not available for systematic study. The previous literature regarding the effect of hydrostatic head on heat transmission and regarding the effect of temperature drop on heat transmission has been discussed elsewhere.[1]

DESCRIPTION OF APPARATUS AND METHOD OF PROCEDURE

These tests were run in the horizontal tube evaporator of the Evaporator Experiment Station at the University of Michigan, which has been described in detail.[2] Briefly, the evaporator body is 25¾ in. wide inside and, in these tests, it was 8 ft. high inside. It was equipped with 156 steel tubes ⅞ in. in outside diameter by ⅛ in. wall, with an effective length of 46¼ in., making a net heating surface on the wet side of 0.883 sq.ft. per tube. The total heating surface was therefore 137.75 sq.ft., or 12.795 sq.m. The arrangement of the tubes is shown in Fig. 1. In calculating the heating surface, no allowance was made for the tube sheets, which are of cast iron, 1¼ in. thick. The tubes are secured in these tube sheets by the standard Swenson tube packing plate (see Fig. 2). When tubes of this size with their centers 1⅜ in. apart are so secured, the pressure of the packing plate results in a spreading of the gaskets until they unite in a practically continuous sheet of rubber, perhaps ⅛ in. thick. The packing plates themselves are 1 in. thick and form a continuous sheet. This combination of 2¼ in. of cast iron and ⅛ in. of rubber offers so much resistance to heat transmission as compared to the ⅛ in. of steel in the tubes proper that it was considered reasonable to omit the tube sheets entirely. In this experimental evaporator the tube sheets are very large, and consequently in this set of experiments a large part of the tube sheet was blanked off. In blanking off holes not in use, the same gaskets and packing plates were used as were used in securing tubes, so that there is no need to consider the upper part of the tube sheets as being a part of the heating surface.

Air was vented from the top of the front steam chest into the vapor space; and from the bottom of the front steam chest through the condensate receiver and back to the vapor space. Condensed water was taken from the front steam chest only.

When the evaporator was boiling smoothly and conditions seemed uniform, at a signal from the recorder the level of condensate in the receiver was marked, and readings of all temperatures and pressures were begun at once. Readings were taken every two minutes until a sufficient amount of condensed water had accumulated; or in the case of runs at high ratings, until at least ten or twelve sets of readings had been taken. At a signal from the recorder the time was again noted and the amount of condensed water again marked. The evaporator was connected to another receiver, and as soon as conditions had become uniform the next run

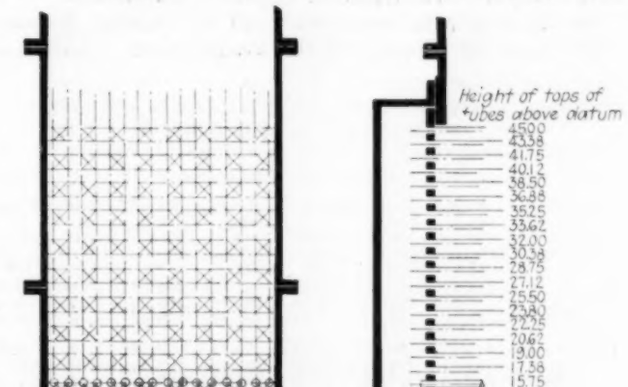

FIG. 1. ARRANGEMENT OF TUBES IN EXPERIMENTAL EVAPORATOR

was started. This usually involved a lapse of five to seven minutes, during which time the evaporator was kept boiling and the conditions kept as constant as possible. In series T there was but one break. Runs 128A, 151B and 259 were made without a shutdown, and then runs 129A, 152B and 260 were also made consecutively. In series U runs 130A-I, -II and -III were made consecutively. There was then a break until the next day, when runs 153B, 154B, 261 and 262 were made consecutively. There was another break, and runs 155B, 156B and 131A were made.

*Read before the American Institute of Chemical Engineers at New Orleans, Dec. 7, 1920.

[1] "Studies in Evaporator Design"—I, II, III and IV, CHEM. & MET. ENG., vol. 23, Nos. 6, 7, 9 and 12, pp. 237, 281, 390 and 569, Aug. 11, 18, and Sept. 1 and 29, 1920.

[2] CHEM. & MET. ENG., vol. 23, No. 4, p. 159, July 28, 1920.

Methods of Measurement and Accuracy of Results

Time was measured with an ordinary watch, and it is probably correct to within ± 2 seconds. The vacuum was controlled by the automatic vacuum regulator described in a previous paper[3] and usually did not vary over ± 2 mm. during a test. Therefore the probable error of the average for a test is very small (less than ± 0.1 mm.). Temperatures of the vapor space were not read systematically, but when read they came so near to the temperature calculated from the vacuum as to indicate no constant error in the manometer

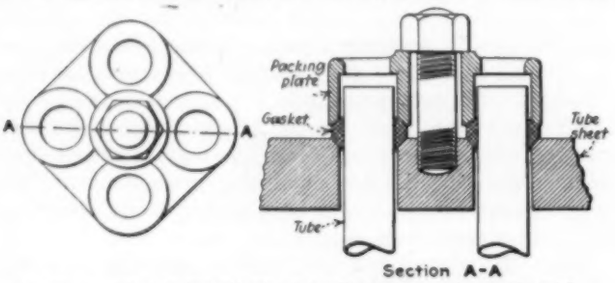

FIG. 2. TUBE PACKING PLATE SHOWING METHOD OF SECURING TUBES

greater than ± 1 mm. (or ± 0.13 deg. C. at 60 deg.). In a previous paper[4] there is a discussion of the reasons for preferring temperature calculated from vacuum as the temperature of the boiling liquid rather than temperature determined by a thermometer inserted into the machine. It should be noted that in calculating on the basis of the temperature corresponding to the vacuum the results are in terms of apparent temperature drop and are therefore apparent coefficients.

Steam pressures were measured by mercury manometers attached directly to the steam chests. Long experience with metal piping (both ordinary iron pipe and fittings and seamless copper tubing) has led us to distrust manometers for steam which are any great distance from the point at which the pressure is to be measured. We therefore abandoned the idea of manometers on an instrument board. A special brass stuffing box was screwed into a tapped hole in the steam chest covers. Glass manometer tubes were made with the end of one arm bent horizontal to enter this stuffing box. Water slowly accumulated in the steam side, but it was measured at each reading and allowed for in the calculations. The average of the manometer readings is probably accurate to less than 1 mm. This is equivalent to ± 0.04 deg. on the saturation temperature for series T, and ± 0.05 deg. for series U.

TABLE I. STEAM TEMPERATURES IN BACK AND FRONT STEAM CHESTS DURING SERIES T

In Degrees Centigrade

Run No.		—Back Steam Chest— Temp. from Therm. I	Temp. from Press. II	Superheat III	—Front Steam Chest— Temp. from Therm. IV	Temp. from Press. V	Superheat VI	Drop in Satn. Temp. VII
128A	I	115.82	100.07	15.75	101.85	100.08	1.77	—0.01
	II	115.80	100.04	15.76	103.26	100.06	3.20	—0.02
	III	114.18	100.01	14.17	104.77	100.07	4.70	—0.06
151B	I	112.35	99.91	12.64	103.13	99.94	3.19	—0.03
	II	112.91	100.01	12.90	103.48	100.38	3.10	*—0.37
	III	114.08	100.08	14.00	103.39	100.06	3.33	+0.02
129A	I	113.64	100.14	13.50	102.23	100.12	2.11	+0.02
	II	114.88	99.96	14.92	102.81	100.02	2.79	—0.06
	III	114.45	100.00	14.45	102.85	99.95	2.90	+0.05
259	I	111.10	100.01	11.09	103.23	99.99	3.24	+0.02
	II	111.28	100.00	11.28	103.25	99.99	3.26	+0.01
	III	110.52	100.04	10.48	103.32	99.98	3.34	+0.06
152B	I	114.21	99.95	14.26	102.29	99.93	2.36	+0.02
	II	115.69	100.03	15.66	102.39	100.02	2.37	+0.01
	III	115.89	100.05	15.84	102.52	100.03	2.49	+0.02
260	I	116.80	100.07	16.73	102.55	100.01	2.54	+0.06
	II	115.55	100.03	15.52	102.28	100.00	2.28	+0.03
	III	115.62	100.03	15.59	101.35	99.98	1.37	+0.05
Average		114.16	100.02	14.14	102.79	100.01	2.78	+0.01

* Omitted.
NOTE.—Column III = Column I − Column II. Column VI = Column IV − Column V. Column VII = Column II − Column V.

TABLE II. STEAM TEMPERATURES IN BACK AND FRONT STEAM CHESTS DURING SERIES U

In Degrees Centigrade

Run No.		—Back Steam Chest— Temp. from Therm. I	Temp. from Press. II	Superheat III	—Front Steam Chest— Temp. from Therm. IV	Temp. from Press. V	Superheat VI	Drop in Satn. Temp VII
261	I	108.13	89.96	18.17	91.40	89.96	+1.44	0.00
	III	108.73	89.95	18.78	91.39	89.86	+1.53	+0.09
262	I	107.48	90.15	17.33	91.32	89.97	+1.35	+0.18
	II	107.82	89.91	17.91	91.07	89.93	+1.14	—0.02
154B	I	110.73	89.99	20.74	91.15	89.95	+1.20	+0.04
	II	110.15	89.94	20.21	91.64	89.95	+1.69	—0.01
130A	I	111.15	90.03	21.12	90.47	90.05	+0.42	—0.02
	II	111.26	89.81	21.45	91.75	89.75	+2.00	+0.06
	III	110.84	89.99	20.85	92.02	90.01	+2.01	—0.02
131A	I	105.60	89.99	15.61	90.06	90.04	+0.02	—0.05
	II	104.97	89.85	15.12	89.89	89.93	—0.04	—0.08
155B	II	104.16	89.81	14.35	88.88	89.69	—0.81	+0.12
	III	104.01	90.03	13.98	89.43	90.01	—0.58	+0.02
156B	I	104.23	90.01	14.22	89.83	90.01	—0.18	0.00
153B	I	109.81	89.90	19.91	89.99	89.88	+0.11	+0.02
Average		107.94	89.95	17.99	90.69	89.93	+0.76	+0.02

NOTE.—Column III = Column I − Column II. Column VI = Column IV − Column V. Column VII = Column II − Column V.

Steam temperatures, because of the accessibility of the steam chests of a horizontal tube evaporator, can be ascertained much more satisfactorily than in the vertical type evaporator. Four calibrated thermometers were inserted in each steam chest, distributed over the part opposite the ends of the tubes in use. The averages of these thermometer readings are given in Tables I and II. (The "back" steam chest is the one in which the steam enters.) The probable error of the average temperature in the back steam chest was about ± 0.3 deg. Condensate temperature was measured in the condensate line about 3 ft. from the steam chest. The error of this reading may have been ± 0.2 deg.

Heat Available

It will be seen from the data of these tables that there was considerable superheat in all the runs. This is because high-pressure steam was used and throttled at the evaporator. The heat transmitted through the heating surface per kg. of steam condensed is, therefore: (1) Heat given up as superheat in cooling to saturation temperature. (2) Latent heat of condensation. (3) Sensible heat given up by condensed water in cooling from saturation temperature to the temperature at which it left the evaporator. (4) Heat given up in cooling from the temperature of the back steam chest to the temperature of the front steam chest, by steam bled through vents or condensed by radiation in condensate lines and condensate receivers. Of these, No. 4 may be omitted as too small to consider. The other items may be readily calculated. In this respect the work on the horizontal tube evaporator is more definite than on the vertical tube evaporator. The superheat may be in error by ± 0.15 cal.; the latent

[3] Chem. & Met. Eng., vol. 23, No. 4, p. 161, July 28, 1920.
[4] Chem. & Met. Eng., vol. 23, No. 6, p. 241, Aug. 11, 1920.

heat by ± 0.03 cal.; and the sensible heat by ± 0.2 cal. Since the total heat given up per kg. of steam condensed was about 550 cal., the greatest probable error would be ± 0.4 cal., or 0.08 per cent.

It is interesting to note that the temperature drop from the back steam chest to the front steam chest (calculated from pressure) was of the order of a few hundredths of a degree. In most cases the drop is toward the front steam chest, as would be expected. In series T, the pressure drop in 151B-II is evidently in error. Omitting this, there is no difference between the two steam chests over 0.18 deg. in either series. The average difference is + 0.01 deg. in series T and + 0.02 deg. in series U.

Calculation of Apparent Temperature Drop

In calculating the apparent temperature drop there are complications due to the presence of superheat. In order to handle the calculations it will be assumed that the processes are as follows: First the steam is cooled to the saturation temperature, giving up its superheat. Next it is condensed to a liquid at a temperature corresponding to the mean of the pressures in the front and back steam chests. Finally, the condensate is cooled from this temperature to the temperature at which it leaves the evaporator. Under these assumptions the following formulation holds: (See Fig. 3.)

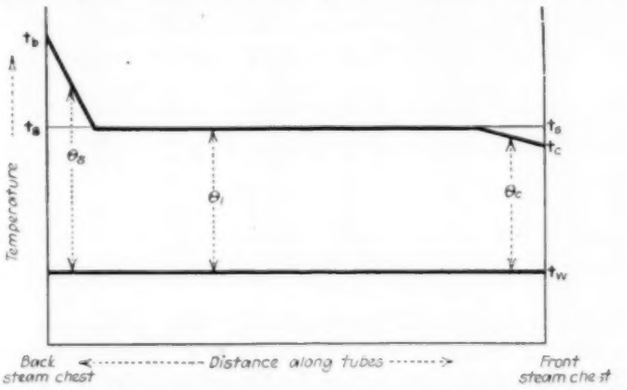

FIG. 3. TEMPERATURE GRADIENT IN THE HORIZONTAL TUBE EVAPORATOR

t_w = temperature of boiling liquid.
t_b = temperature of superheated steam entering tubes from back steam chest.
t_s = temperature of saturated steam in tubes.
t_c = temperature of condensed water.

t_b = temperature of back steam chest from thermometers.
t_f = temperature of front steam chest from thermometer.
t_s = temperature of saturated steam corresponding to mean of the pressures of front and back steam chests.
t_c = temperature of condensed water.
t_w = temperature corresponding to vacuum.
θ_s = mean temperature difference during transfer of superheat.
θ_l = mean temperature difference during transfer of latent heat.
θ_c = mean temperature difference during transfer of sensible heat of condensate.
H_s = Heat as superheat in cal. per kg.
H_l = latent heat in calories per kg.
H_c = sensible heat recovered from 1 kg. of condensate.
θ_m = mean apparent temperature drop.

Then

$$\theta_s = \frac{(t_b - t_w) + (t_s - t_w)}{2} \quad (1)$$

$$\theta_l = t_s - t_w \quad (2)$$

$$\theta_c = \frac{(t_s - t_w) + t_c - t_w}{2} \quad (3)$$

$$\theta_m = \frac{\theta_s H_s + \theta_l H_l + \theta_c H_c}{H_s + H_l + H_c} \quad (4)$$

In equations 1 and 3 the arithmetical mean has been used instead of the logarithmic mean. This is because H_s and H_c are so small that the error so made in θ_s and θ_c is without significance in the final result.

The above method of calculation was applied to a number of runs. The results of a few, selected because they represent extremes, appear in Table III. As will be seen, H_s and H_c are so small in comparison with H_l that they are not significant. In view of the amount of calculating saved, θ_l has been used in all the data of this paper instead of θ_m. The total heat available from 1 kg. of steam condensed was, however, determined by taking the sum of H_s, H_l and H_c. Hence the values used for θ may be in error by not over ± 0.2 deg. due to this method of calculation. As stated above, t_w has an error of ± 0.13 deg., and t_s ± 0.05 deg. Therefore the final values for θ may have a maximum error of ± 0.4 deg. or ± 2.6 per cent, in series U and ± 1.6 per cent in series T.

TABLE III. CALCULATION OF MEAN APPARENT TEMPERATURE DROP (θ_m)

$$\theta_m = \frac{H_s\theta_s + H_l\theta_l + H_c\theta_c}{H_s + H_l + H_c}$$

Run	Series T 128A I	Series T 259 III	Series T 260 I	Series U 130 A I	Series U 261 II	Series U 155B III
t_w	75.02	75.08	75.10	75.20	74.96	74.98
t_b	115.82	110.52	116.80	111.15	108.73	104.01
t_s	100.08	100.01	100.04	90.04	89.91	90.02
Superheat	15.74	10.51	16.76	21.11	18.82	13.99
t_s	7.66	5.12	8.15	10.15	9.04	6.72
l_l	538.65	538.69	538.68	544.88	544.96	544.89
l_c	0.34	0.19	0.20	0.71	0.90	1.01
$l_s + l_l + H_c$	546.65	544.00	547.03	555.74	554.90	552.62
θ_s	32.93	30.18	33.32	25.40	24.36	22.03
θ_l	25.06	24.93	24.94	14.84	14.95	15.04
θ_c	24.89	24.83	24.84	14.48	14.50	14.54
$l_s\theta_s$	252.24	154.52	271.56	257.81	220.21	148.04
$l_l\theta_l$	13,498.57	13,429.54	13,434.68	8,086.02	8,147.15	8,195.15
$l_c\theta_c$	8.46	4.72	4.97	10.28	13.85	14.69
$l_s\theta_s + l_l\theta_l + H_c\theta_c$	13,759.27	13,588.78	13,711.21	8,354.11	8,380.41	8,357.88
θ_m	25.17	24.98	25.07	15.03	15.10	15.12
$\theta_m - \theta_l$	+0.11	+0.05	+0.13	+0.19	+0.15	+0.08

In all cases temperatures were read to tenths of degrees and pressures to millimeters of mercury. In all calculations temperatures were carried to hundredths of degrees and pressures to tenths of millimeters. The final results were rounded off to the nearest whole number for the values of K and U. So far as the probable error of any of the determinations goes, the final result is probably accurate to 1 to 2 per cent. However, the possibility of systematic errors makes us doubtful whether we should assign a greater accuracy than ± 50 to any figures for K. Duplicates can be obtained closer than this.

Results

The data for the two series are given in Table IV and are plotted in Fig. 4. From the data of these tables it would seem that in runs 131A, 155B and 156B, there was not enough venting from the front steam chest, so that some air accumulated at that point. In series T steam pressures throughout were above atmospheric pressure and therefore it was easy to keep the steam chests free of air.

Effect of Superheat

The question on the effect of the presence of superheat is one which has been discussed many times in the literature. A few scattered tests are available to show the effect of superheat, but as a general thing they are not systematic and lead to contrary conclusions. In no case have tests been carried out where the total heat transmitted was entirely or even largely superheat.

TABLE IV. HEAT TRANSMISSION DATA OBTAINED IN SERIES T AND U

Run	Level	Time Min.	Abs. Vac.	Corres. Temp.	Abs. Steam Press.	Series T Corres. Temp. Steam	Actual Temp. Steam	Superheat	Cond. Temp.	Cond. Lb.	θ	K	U
128A I	6.03	10.0	289.3	75.02	762.1	100.08	115.82	15.76	99.74	457.7	25.06	2,123	434.8
128A II	5.92	16.0	289.4	75.03	761.3	100.05	115.80	15.75	99.79	740.5	25.02	2,150	440.3
128A III	6.00	15.0	290.3	75.14	760.2	100.01	114.18	14.17	99.56	546.1	24.90	2,138	437.8
151B I	12.41	16.0	290.5	75.12	758.5	99.94	112.55	12.61	99.65	719.1	24.82	2,100	430.0
151B II	12.93	14.0	289.4	75.03	770.5	100.38	112.41	12.03	100.07	650.4	25.35	2,124	434.9
151B III	12.25	16.0	289.9	75.07	761.9	100.07	114.08	14.01	99.85	731.6	25.00	2,123	434.8
259 I	18.10	16.0	289.9	75.07	760.1	100.00	111.10	11.10	99.79	694.4	24.93	2,016	412.8
259 II	17.87	16.0	290.0	75.08	759.8	99.99	111.28	11.29	99.79	698.1	24.91	2,028	415.2
259 III	18.03	16.0	290.0	75.08	760.2	100.01	110.52	10.51	99.82	700.2	24.93	2,031	415.9
129A I	23.80	18.0	289.7	75.06	763.5	100.13	113.64	13.51	99.89	672.7	25.07	1,729	354.1
129A II	23.97	16.0	289.4	75.03	759.8	99.99	114.88	14.89	99.87	599.9	24.96	1,745	357.4
129A III	24.10	20.0	290.2	75.10	759.5	99.98	114.45	14.47	99.89	756.8	24.88	1,766	361.6
152B I	35.90	20.0	289.4	75.03	758.4	99.94	114.21	14.27	99.72	676.0	24.91	1,575	322.5
152B II	36.23	20.0	289.6	75.05	760.7	100.03	115.69	15.66	99.71	684.0	24.98	1,592	326.1
152B III	36.03	20.0	289.3	75.03	761.2	100.04	115.89	15.85	99.80	688.2	25.01	1,600	327.6
260 I	47.97	16.0	290.2	75.10	761.1	100.04	116.80	16.76	99.84	482.2	24.94	1,406	287.9
260 II	48.05	20.0	290.8	75.15	760.4	100.01	115.55	15.54	99.92	604.9	24.86	1,414	289.5
260 III	48.18	16.0	287.8	74.90	760.1	100.00	115.62	15.62	99.92	483.2	25.10	1,398	286.3
Average	.....	.....	289.7	75.06	.....	100.04	.....	.....	.....	.....	24.98	.....	.....
						Series U							
153B I	6.17	24.0	290.7	75.14	523.8	89.90	109.81	19.91	88.73	438.0	14.76	1,461	299.2
154B I	9.00	20.0	288.9	74.99	525.1	89.96	110.73	20.77	89.13	400.9	14.97	1,582	324.0
154B II	9.28	18.5	284.9	74.66	524.8	89.95	110.15	20.20	88.97	370.7	15.29	1,549	317.1
130A I	12.10	20.0	291.4	75.20	526.6	90.04	111.15	21.11	89.33	378.5	14.84	1,508	308.8
130A II	11.95	20.0	288.8	74.98	521.4	89.78	111.26	21.48	89.02	379.5	14.80	1,516	310.5
130A III	12.00	20.0	293.5	75.37	525.9	90.00	110.84	20.84	89.47	413.9	14.63	1,671	342.2
261 I	17.87	20.0	289.6	75.05	525.0	89.96	108.13	18.17	89.12	340.0	14.91	1,345	275.4
261 II	17.97	20.0	288.5	74.96	524.0	89.91	108.73	18.82	89.01	342.4	14.95	1,351	276.7
262 I	23.97	20.0	288.0	74.92	525.7	89.99	107.48	17.49	89.16	340.4	15.07	1,190	243.7
262 II	24.08	24.0	285.9	74.74	524.2	89.92	107.82	17.90	88.93	368.7	15.18	1,194	244.5
155B II	35.95	21.0	286.4	74.76	520.8	89.75	104.16	14.41	88.69	270.1	14.99	1,009	206.7
155B III	35.95	20.0	288.8	74.98	526.2	90.02	104.01	13.99	89.01	230.2	15.04	899	184.2
156B I	35.97	20.0	287.2	74.85	527.8	90.10	104.23	14.13	89.02	239.9	15.25	925	189.4
131A I	48.08	24.0	290.5	75.12	524.9	89.95	105.60	15.65	88.98	255.6	14.83	845	173.1
131A II	49.30	24.0	289.4	75.03	522.2	89.82	104.97	15.15	88.68	231.6	14.79	768	157.3
Average	.....	.....	288.8	74.98	.....	89.94	.....	.....	.....	.....	14.96	.....	.....

The writer's point of view is as follows:

The amount of heat in superheat under conditions at which we work is so small a proportion of the total heat transmitted that most of the heating surface is actually transmitting heat from saturated steam. The small part of the heating surface which transmits heat from superheated steam may be working at a rate which is relatively very low, but this part of the surface is too small to affect the results appreciably.

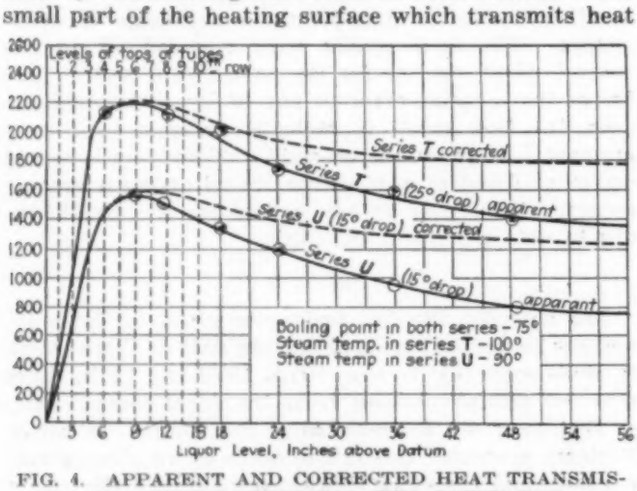
Levels of tops of tubes
1 2 3 4 5 6 7 8 9 10 — row
Series T corrected
Series T (25° drop) apparent
Series U (15° drop) corrected
Series U (15° drop) apparent
Boiling point in both series – 75°
Steam temp. in series T – 100°
Steam temp in series U – 90°
Liquor Level, Inches above Datum

FIG. 4. APPARENT AND CORRECTED HEAT TRANSMISSION COEFFICIENTS FOR TWO DIFFERENT TEMPERATURE DROPS (SERIES T AND U)

It will be noted that these statements are purely qualitative. For the present we prefer not to attempt to deal in numerical statements. By a rearrangement of the steam lines in the experiment station it is now possible to operate the horizontal tube evaporator on steam of pressure low enough so that there is no appreciable superheat, even in the steam chest. By a comparison with the runs here reported we hope to confirm the above qualitative statements with quantitative data in the near future.

The data of Table IV are apparent heat transmission coefficients—that is, they are determined by dividing the total heat transmitted by the apparent temperature drop. They may be corrected for effect of hydrostatic head by the following method. (See Fig. 5.)

In addition to the nomenclature given above under

TABLE V. CALCULATION OF HYDROSTATIC HEAD CORRECTIONS FOR SERIES T AND U

Level	Series T — Levels Below Top of Tubes 6 In.	12 In.	Series U — 6 In.	12 In.
H_a	7.874 sq.m.	2.6247	7.874	2.625
H_b	4.9213	10.171	4.920	10.169
t_b	75.90	76.77	75.84	76.81
θ_2	24.14	23.27	14.12	13.23
θ_4	24.56	24.12	14.54	14.10
θ_{mh}	24.82	24.30	14.80	14.27
Apparent K	2,140	2,125	1,425	1,500
Correct K	2,153	2,182	1,440	1,573
	t_s = 100.04°C.		t_s = 89.94°C.	
	t_{sp} = 75.06°C.		t_{sp} = 74.98°C.	
	θ_1 = 24.98°C.		θ_1 = 14.96°C.	

Level	Levels Above Top of Tubes 18 In.	24 In.	36 In.	48 In.	18 In.	24 In.	36 In.	48 In.
t_b	77.64	78.45	80.01	81.49	77.53	78.36	79.92	81.40
t_r	75.39	76.27	77.95	79.53	75.32	76.20	77.89	79.46
θ_2	22.40	21.59	20.03	18.55	12.41	11.58	10.02	8.54
θ_3	24.65	23.77	22.09	20.51	14.62	13.74	12.05	10.48
θ_{mh}	23.53	22.68	21.06	19.53	13.52	12.66	11.04	9.51
Apparent K	1,930	1,765	1,550	1,400	1,345	1,190	960	810
Correct K	2,049	1,940	1,840	1,792	1,488	1,406	1,302	1,275

the calculation of temperature drop, the following are needed:

p_v = absolute pressure in vapor space.
p_h = hydrostatic head on bottom of heating surface.
p'_h = hydrostatic head on top of heating surface.
p_b = total pressure on bottom of heating surface.
p_t = total pressure on top of heating surface.
t_b = temperature corresponding to p_b.
t_t = temperature corresponding to p_t.

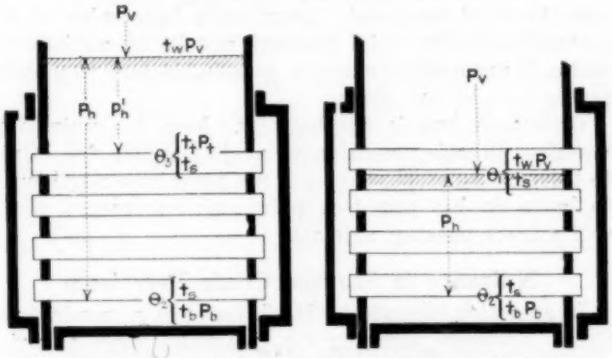

FIG. 5. ILLUSTRATION OF METHOD OF CORRECTING HEAT TRANSMISSION COEFFICIENTS FOR EFFECT OF HYDROSTATIC HEAD

For those cases where the liquid is above the top of the heating surface we have the following:

θ_1 = apparent temperature drop = $t_s - t_{tc}$.
$p_t = p_v + p'_h$.
$p_b = p_v + p_h$.
$\theta_2 = t_s - t_b$ = temperature drop at bottom of heating surface.
$\theta_3 = t_s - t_t$ = temperature drop at top of heating surface.
θ_{mh} = mean temperature drop corrected for effect of hydrostatic head = $\frac{\theta_3 + \theta_2}{2}$

For those cases where the liquor level is below the top of the heating surface the formulation becomes:

$p'_h = 0$, hence $t_t = t_{tc}$.
$\theta_2 = t_s - t_b$ = temperature drop at bottom of heating surface.
H_a = heating surface above liquor level.
H_b = heating surface below liquor level.
$\theta_4 = \frac{\theta_1 + \theta_2}{2}$ = mean temperature drop over submerged part of heating surface.
$\theta_{mh} = \frac{H_a\,\theta_1 + H_b\,\theta_4}{H_a + H_b}$

There are certain errors made in the above corrections of which the writer is aware but which do not introduce enough error to be significant. In particular, the mean temperature drop is, of course, not the arithmetical mean of the temperature drops at top and bottom of heating surface, but is determined by some other function which involves the relation between the vapor pressure of water and temperature. Averages obtained by graphic integration of the vapor pressure curve for water over the pressure ranges involved in these hydrostatic head corrections showed differences from arithmetical mean of only 0.02 to 0.03 deg.

TABLE VI. RATIO OF CORRECTED VALUES, SERIES U, TO CORRECTED VALUES, SERIES T

Level, In.	Ratio U : T
10	0.721
12	0.721
18	0.725
24	0.724
36	0.708
48	0.712

The great similarity of the curves, series U and series T, is at once evident; and some search was made for a quantitative relation. Table VI showing the ratios of the corrected values in the two series indicates at once a very useful relation—namely, that if the ratio of heat transmission coefficients for different temperature drops is determined for a given evaporator at any one liquor level, the same ratio may be used for other liquor levels with an accuracy far greater than that now involved in any other part of the design.

Conclusions

The following conclusions must for the present be considered as indicating tendencies only, and must be applied with caution to evaporators differing much in design from the one in which they are determined.

1. In horizontal tube evaporators the maximum capacity occurs when the tubes are from half to two-thirds submerged.

2. The maximum capacity is reached at levels nearer the top of the heating surface as the apparent temperature drop becomes smaller.

3. The maximum apparent heat transmission coefficient is 105 to 108 per cent of the heat transmission coefficient where the liquor level is at the top of the heating surface.

4. The ratio of corrected heat transmission coefficients for two different temperature drops is constant for all levels above the optimum.

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Ann Arbor, Mich.

Pronounced Benefits From Preliminary Impregnation of Pulpwood Chips*

Impregnating pulpwood chips with cooking liquor under pressure before the cooking action has commenced has been found decidedly advantageous in the soda and sulphate processes of pulping. The required pressure is obtained by pumping cooking liquor into the digester after it has been completely filled and closed. The amount of pressure necessary, duration of treatment and other factors vary with the type of cooking process, kind of chips used and quality of paper sought.

Laboratory cooks of treated chips on a 50-lb. scale showed greater uniformity of cooking, increased yields, reduced bleach consumption, increased concentration of the cooking liquor and reduced time for cooking.

Mill trials of the improved method on a 3-ton scale resulted in increased concentration of the cooking liquor, reduced time for cooking, a reduction of the steam required for cooking from 9,000 to 6,000 lb. per digester charge and an increase in the concentration of black liquor from the digester from 15 to 18 deg. Bé.

The saving in time required for cooking was estimated to be sufficient to offset the time required for impregnation. The saving in steam consumption made possible an increase of from 12 to 20 cooks per day from a 250-hp. steam boiler. The increase in the density of the cooking liquor was estimated to make possible an increase of 25 per cent in the output of the recovery house.

*From U. S. Forest Products Laboratory *Technical Notes*.

Legal Notes

By Wellington Gustin

Nitric Acid With Sulphuric Acid Added to Prevent Corrosion Not Subject to Duty

The Supreme Court of the United States has upheld the judgment of the Court of Customs Appeals in the proceedings on protests of the Aetna Explosives Co. against assessments of duty on imported goods. (41 Sup. Ct. R. 513.)

The imported merchandise was nitric acid to which 20 per cent by weight and 5 per cent according to value of sulphuric acid had been added for the sole purpose of preventing corrosion of steel tank cars necessary for transportation of the nitric acid in large quantities. The court below found that the sulphuric acid was added solely for transportation purposes and that the result was not a product merchantable as such for use in the United States. Hence it held that no duty should have been demanded, and the Supreme Court affirms this decision.

In the 1913 tariff act, paragraph 387, including nitric and sulphuric acid in the free list, and paragraph 5, imposing a duty of 15 per cent ad valorem on all chemical and medicinal compounds, preparations and mixtures, nitric acid, to which sulphuric acid amounting to 20 per cent by weight and 5 per cent according to value has been added solely to prevent corrosion of the steel-carrying tank cars, is not subject to duty as a "preparation" or mixture.

The merchandise was not a commercial mixture contemplated by the statute. It was susceptible of no use other than as nitric acid, which must be treated again before use. The court said the mixing of this minimum amount of sulphuric acid should be treated as a means of and part of the shipment, and as an act as essential in the importation of nitric acid as would have been the proper packing of glassware or other goods designed for shipment by rail.

Cyanide Pond Owners Liable for Death of Live Stock

The case of Williams Estate Co. vs. Nevada Wonder Mining Co., 196 Pacific, 844, involves the liability of the mining company for loss of cattle from drinking cyanide solutions discharged from its mill, located at Wonder, Nev. It appears that the solutions flowed down a slope for a mile or so and there were collected in a pond. This pond was situated for the most part on mining ground owned by the mining company but extended over onto the public domain. These cyanide solutions are highly poisonous, but as they resemble water are attractive to cattle and other live stock. The mining company kept the pond fenced with barbed wire and posted notices warning owners of live stock of its dangerous contents. The company generally kept two men to impound these cyanide solutions, and on the day of the loss for which suit was brought the solutions broke through the levee of the pond and flowed outside the fence.

Plaintiff's cattle coming from the open range were attracted to the spot, drank the solutions and died.

A judgment was rendered for the loss of the cattle in the District Court and the Supreme Court of Nevada has affirmed this decision. Nevada has no law requiring stockmen to keep their stock within inclosures, and they may lawfully permit such to roam at will and graze over the public ranges and also over unfenced land of private owners. In fact, a herder of horses or cattle upon public and other uninclosed lands is unknown to the stockmen in Nevada, says the court, and a mine owner creating a cyanide pond in proximity to and in open view of the public range, with knowledge of the poisonous nature of its contents and its attractions for cattle, is required to exercise reasonable care to prevent access to it by live stock.

Ordinarily one is not bound to keep his uninclosed premises in safe condition to avoid liability for injury to trespassing stock, but he is not permitted negligently to leave on his premises poisonous substances which will attract passing animals.

Nuisance in Storage Crude Petroleum

In an action brought by H. A. Lutes et al. against the Great Northern Refining Co., plaintiffs were awarded damages through defendant's erection and maintenance of an oil tank shipping rack in close proximity to their residence. It was charged that crude petroleum was being constantly pumped through the tank to the cars for shipment and that the gases and fumes escaping from the crude oil were so offensive, disagreeable and injurious as to constitute a nuisance and so as to make their residence uninhabitable. It was further alleged that because the oil was impregnated with gas and was highly flammable they were in constant danger of having their property destroyed by fire. (227 S.W., 795.)

The Court of Appeals of Kentucky reversed the Circuit Court's judgment for an error on the trial and a new trial was ordered. This court lays down the law that the storage of oil upon one's premises is not *per se* a nuisance. A lawful business cannot be a nuisance *per se*, but the character of the business, the manner in which it is conducted and its proximity to other buildings and the surrounding circumstances may be such as to create a nuisance. It is not every annoyance that will give a right of action to the complaining party. A nuisance is that which offends the olfactory nerves of an ordinary man, and not those of an individual with sensitive and delicate nostrils.

Further, the court says, every one who brings or stores oil on land must confine it securely in pipes, tanks or reservoirs, or at least not permit it to escape onto the land of another, whether by flowing over the surface or percolating through the soil, and if one does not, even though guilty of no negligence, he will be liable for whatever damage is suffered by the oil escaping. This is true, although the refining of oil is a perfectly legitimate business. Nor is the owner of property, injured by the operation of oil wells or works, confined to instances where the oil actually enters upon his premises, as he may recover because of noxious odors occasioned by their operation rendering his premises unhealthful or objectionable to live upon.

However, the court said, the question of prospective damage from fire should not have been submitted to the jury. It was too problematical. Ordinarily the mere anticipatory loss by fire because of the possibility that the tank might be struck by lightning or fired by a spark from a locomotive does not form a basis for a legal recovery. It might never happen; and if it did, and the owner was negligent, there would be a proper remedy.

Preliminary Summaries of 1919 Census of Manufactures

Tabulated Statistics for Chemicals, Drug Preparations, Natural Dyes and Extracts, Fertilizers, Gas, Leather, Paper and Wood Pulp, Petroleum Refining, Rubber Goods, Soap, Brass, Bronze and Copper Products, Pig Iron, Industrial Power and Fuel Consumption in Superpower Zone

PRELIMINARY statements of the general results of the 1919 census of manufactures with reference to a number of chemical and metallurgical industries have been issued by the Bureau of the Census. Comparative statistics for 1919 and 1914 are summarized in the following tables, figures for 1919 being subject to such change and correction as may be necessary from further examination of the original reports.

CHEMICAL INDUSTRY

The chemical industry is subdivided for establishments primarily engaged in the manufacture of (a) chemicals in general; (b) coal-tar chemicals; and (c) sulphuric, nitric, and mixed acids; and the figures are based upon returns from 811 establishments, with products valued at $603,555,400. In addition chemical products were reported by 563 establishments primarily engaged in other lines of manufacture, to the value of $91,087,600, making a total of 1,374 establishments and $694,643,000 in value of products.

At the census of 1914 there were in the aggregate 754 establishments, with products valued at $200,195,800, showing an increase of $494,447,200 or 247 per cent.

CHEMICAL INDUSTRY, 1919 AND 1914

	1919		1914	
	No. of Establishments	Value	No. of Establishments	Value
Total	1,374	$694,643,000	754	$200,195,800
Chemical industry	589	436,602,800	395	158,053,600
Coal-tar products industry	183	135,482,100	.....	.....
Sulphuric, nitric and mixed acids industry	39	31,470,500	32	15,215,500
Subsidiary chemical products, other industries	563	91,087,600	327	26,926,700

	Quantity	Value	Quantity	Value
Acids (*a*)	.....	$78,117,800	.....	$30,516,600
Acetic and pyroligneous, lb.	46,821,000	2,816,300	70,617,600	1,272,300
Acetic, glacial, lb	5,050,000	869,200		
Acetic anhydride, lb	1,213,200	578,600	.....	.....
Boric (boracic), lb	14,454,100	1,754,600	8,584,300	589,000
Citric, lb	3,163,700	3,047,400	2,657,800	1,516,300
Hydrochloric, tons	147,130	4,312,300	85,440	1,348,800
Hydrofluoric, lb	5,675,400	440,200	5,373,700	325,600
Mixed (sulphuric, nitric) tons	48,430	4,426,600	42,725	2,204,500
Nitric, tons	19,440	2,976,100	14,685	1,591,600
Oleic, lb	44,350,600	6,548,600	21,932,700	1,301,400
Phosphoric, lb	13,379,500	1,711,100	12,420,200	680,200
Stearic, lb	16,969,900	3,796,400	14,351,400	1,242,500
Sulphuric (basis 50 deg.), tons	3,296,270	35,638,200	2,338,280	15,395,100
Lactic, lb	5,054,500	781,500	.....	3,049,300
Oxalic, lb	2,103,500	545,600		
Tartaric, lb	5,313,000	4,262,400		
Other, lb	.....	3,612,500		
Sodas and sodium compounds	.....	90,913,100	.....	32,594,800
Bicarbonate, tons	141,560	3,695,400	90,170	1,439,000
Borax, tons	21,435	4,622,300	20,500	2,071,800
Caustic soda, tons	319,490	20,494,800	212,540	6,657,500
Salsoda, tons	71,830	2,102,200	106,590	1,510,500
Soda ash, tons	1,033,480	31,195,200	935,305	10,937,900
Sodium bichromate, tons	22,990	5,337,400	11,820	1,125,400
Phosphate, tons	22,350	2,438,900	15,400	853,500
Silicate, tons	286,790	6,052,300	169,050	1,648,900
Sulphate (glauber salts), tons	37,390	843,500	34,540	427,800
Salt cake, tons	175,010	2,084,300	90,440	841,900
Sulphides, tons	35,180	2,316,300	20,260	516,600
Other	.....	9,730,500	.....	4,564,000
Potash and potassium compounds	.....	16,409,500	.....	7,219,900
Bitartrate (cream of tartar), lb	2,854,550	2,620,400	12,646,120	3,125,000
Caustic potash, lb	12,625,000	2,163,400	.....	4,094,900
Potash from original sources, tons	106,000	7,110,100		
Other	.....	4,515,600		
Alums, tons	327,070	$16,677,600	156,860	$3,468,000
Ammonia and cyanogen compounds	.....	46,549,000	.....	8,065,000
Anhydrous ammonia, tons	27,350	10,861,600	8,330	3,140,900
Aqua ammonia, tons	16,680	3,245,400	17,770	1,412,200
Ammonium chloride, tons	6,060	1,426,100	5,760	641,100
Ammonium sulphate, tons	294,880	22,638,600	(*b*) 4,423	(*b*) 211,300
Other ammonium salts	.....	2,476,300	.....	260,800
Cyanides	.....	5,901,000	.....	2,398,700
Leaching compounds	.....	10,582,800	.....	5,302,400
Chlorine, lb	34,391,800	1,425,900	12,217,000	472,900
Hypochlorite, lime, tons	88,570	3,418,500	155,190	2,916,200
Hypochlorite, sodium, tons	37,860	1,362,800		
Peroxide, hydrogen, lb	31,515,000	2,257,300	32,595,000	1,303,600
Peroxide, other	.....	449,100	.....	.....
Sodium bisulphite	38,717,000	948,700	.....	609,700
Other sulphur bleaches	.....	129,300	.....	.....
All other	.....	592,200	.....	.....
Coal-tar products	.....	133,340,900	.....	8,839,500
Finished products, lb	82,532,400	84,515,500	.....	.....
Dyes, lb	63,402,200	67,598,900	.....	.....
Color lakes, lb	7,569,900	4,180,000	.....	.....
Photographic chemicals, lb	325,500	1,059,300	.....	.....
Medicinals, lb	6,778,000	7,883,100	.....	.....
Flavors (saccharine, etc.), lb	610,800	1,318,600	.....	.....
Perfume materials, lb	41,400	164,300	.....	.....
Synthetic phenolic resins, lb	3,094,600	2,311,300	.....	.....
Crudes and intermediates	.....	48,825,400	.....	.....
Compressed and liquefied gases	.....	33,154,200	.....	4,484,000
Carbon dioxide, lb	59,771,400	6,574,200	50,445,780	2,320,700
Nitrous oxide, gal	22,376,000	515,200	17,838,000	213,100
Oxygen, M.cu.ft	1,173,400	16,577,400	104,700	1,829,400
Other	.....	(*c*) 9,487,400	.....	(*d*) 120,800
Plastics	.....	77,477,000	.....	13,895,800
Pyroxylin	.....	30,169,000	.....	8,876,500
Rubber substitutes	.....	1,456,000	.....	428,600
Viscose, collodion and other	.....	45,852,000	.....	4,590,700
Chemicals produced by the aid of electricity	.....	67,543,800	.....	29,661,900
Not elsewhere included (aluminum, calcium carbide, abrasives, ferro-alloys, phosphorus, etc.)	.....	48,297,900	.....	24,614,600
Included in other groups (duplication)	.....	19,245,900	.....	5,047,300
Aldehydes-formaldehyde, lb	19,663,800	3,938,300	8,426,200	655,200
Other	.....	1,794,300	.....	(*e*)
Esters:				
Amyl acetate, lb	704,600	350,600	1,300,000	465,700
Ethyl acetate, lb	2,251,000	340,000	.....	(*e*)
Ethyl chloride, lb	248,100	166,200	.....	(*e*)
Other	.....	1,114,400	.....	(*e*)
Ethers:				
Ethyl (sulphuric), lb	4,111,800	1,103,700	2,120,000	278,800
Other	.....	22,600	.....	(*e*)
Ketones:				
Acetone, lb	6,045,900	767,000	10,425,800	1,099,600
Methyl ethyl, lb	1,158,000	167,700	.....	(*e*)
Other	.....	225,100	.....	.....
Misc. organic chemicals:				
Carbon tetrachloride, lb	9,811,800	803,600	.....	(*e*)
Chloroform, lb	1,677,600	516,600	1,334,000	295,300
Glycerine, refined, lb	64,342,800	20,724,000	58,810,400	10,779,200
Glycerine, crude (for sale), lb	21,304,300	2,961,600	16,568,900	2,279,000
Vanillin, lb	134,700	1,365,900	120,600	525,200
Other	.....	18,813,900	.....	(*e*)
Metal salts, n.e.s. (Salts of):				
Antimony, lb	4,045,600	1,190,000	.....	(*e*)
Arsenic (other than lead arsenate)	.....	1,290,800	.....	(*e*)
Barium sulphate (blanc fixe) lb	13,626,000	256,100	18,278,000	257,400
Barium, other salts	.....	1,422,300	.....	103,200
Bismuth, lb	502,300	1,235,500	.....	(*e*)
Calcium acetate, lb	152,634,000	2,682,200	163,522,000	2,138,900
Calcium chloride, lb	149,397,000	1,043,300	.....	(*e*)
Calcium phosphate, lb	43,910,000	4,709,200	.....	(*e*)
Calcium, other salts, lb	.....	427,500	.....	(*e*)
Chromium	.....	1,192,340	.....	(*e*)
Cobalt	.....	104,970	.....	.....
Copper sulphate (blue vitriol), lb	35,288,000	2,825,550	37,152,000	1,598,900
Copper, other salts	.....	410,200	.....	14,380
Gold, oz	14,844	143,070	28,817	291,660
Iron sulphate (copperas), lb	119,611,000	1,046,900	92,479,000	352,770
Iron, other salts	.....	1,694,700	.....	839,000
Lead arsenate, lb	11,465,800	2,090,300	8,641,900	511,700
Lead acetate, lb	4,183,600	552,400	7,290,900	474,430
Lead, other salts	.....	335,500		
Magnesium sulphate (epsom salts), lb	58,696,600	1,497,000	29,265,000	297,000
Magnesium oxide (calcined), lb	9,031,600	1,176,860	.....	(*e*)

	Quantity	Value	Quantity	Value
Magnesium carbonate (precipitated), lb	2,064,700	$85,700	.....	(c)
Magnesium, other salts	.....	788,600	.....	(c)
Mercury, lb	1,143,800	1,775,000	605,700	$518,000
Nickel, lb	1,059,800	640,200	409,500	157,150
Silver nitrate, oz	3,017,900	2,184,000	2,563,200	846,060
Silver, other salts	.....	257,700		
Strontium, lb	529,450	319,400	.....	(c)
Tin chloride, lb	8,999,200	2,986,500	8,291,200	2,028,500
Tin oxide, etc., lb	1,352,600	900,240		
Zinc chloride, lb	74,089,000	4,349,100	40,786,900	1,130,960
Zinc sulphate, lb	7,325,500	267,000		
Zinc, other salts, lb	.....	785,540		
Radium, mg	25,381	2,743,670	.....	1,388,480
Cerium, titanium, thorium and uranium	.....	900,550		
Other chemicals, n.e.s	.....	7,014,110	.....	23,568,300
Chemical byproducts and residues	.....	25,108,000	.....	4,407,600
Other byproducts and contract work	.....	9,514,700	.....	3,890,800

(a) Coal-tar acids included with "coal-tar products."
(b) Not including ammonium sulphate product of byproduct coke and gas plants—88,490 tons, value $4,830,786.
(c) Includes acetylene, hydrogen, nitrogen, argon, etc.
(d) Not including acetylene in containers 121,696 M.cu.ft.; $2,317,605; which was included in the manufactured gas industry.
(e) Figures not available.

Druggists' Preparations, Patent Medicines, Perfumery and Cosmetics

Three related industries—druggists' preparations, patent medicines and compounds, and perfumes and cosmetics—are treated in the following table:

DRUGGISTS' PREPARATIONS, PATENT MEDICINES, AND PERFUMERY AND COSMETICS, 1919 AND 1914

	Number of Establishments		Value of Products	
	1919	1914	1919	1914
Total	....	....	$409,769,800	$176,747,000
Druggists' preparations—industry	524	416	$114,596,900	$48,009,700
Subsidiary products from other industries	42	....	13,344,300	5,353,600
Patent medicines and compounds, industry	2,468	2,903	212,185,700	102,463,400
Subsidiary products from other industries	151	....	6,878,100	3,202,000
Perfumery and cosmetics—industry	570	496	59,630,100	16,899,100
Subsidiary products from other industries	61	....	3,134,700	819,200

Classified Products				
Alkaloids and derivatives	1919			
Production, lb	481,056			
Made and consumed, lb.	23,160			
For sale, lb	457,896	....	....	15,416,000	16,231,500
Biological products (serums, vaccines, toxins)		94	98	15,876,400	6,223,500
Tinctures, fluid extracts, medicinal syrups		406	347	38,679,500	13,900,400
Pills, tablets, powders, etc		403	281	37,790,900	10,903,000
Pharmaceutical metals and their salts and synthetic preparations (a)		28	130	825,500	2,117,300
Patent and proprietary medicines containing opium, codein, heroin, morphine or cocaine		231	2,460	2,951,100	83,455,300
Not containing any of said narcotics		1,909		159,520,800	
Patent and proprietary compounds		1,030	1,075	46,376,600	16,514,300
Perfumery and cosmetics and toilet preparations		938	932	69,470,400	19,160,400
Flavoring essences and extracts		....	....	5,241,500	8,241,300
All other products		....	....	17,621,100	

Materials				Quantity	Cost
				Lb.	
Alkaloidal materials:					
Cinchona bark	1919	99	....	1,220,000	$450,300
Coca leaves	1919	15	....	584,000	292,800
Opium	1919	280	....	102,761	956,354
	1914	....	....	118,287	(b)
Codein and salts	1919	181	....	2,312	296,392
Heroin (diacetyl morphine) and salts	1919	178	....	702	178,585
	1914	....	....	2,306	(b)
Morphine and salts	1919	217	....	3,984	635,912
	1914	....	....	19,758	(b)
Caffein and salts	1919	253	....	39,413	312,285
Cocaine and salts	1919	112	....	516	90,454
	1914	....	....	25,891	(b)
Nicotine and salts	1919	8	....	4,327	6,717
Quinine and salts	1919	439	....	183,516	2,718,238
Strychnine and salts	1919	282	....	16,414	372,304
Other alkaloids or derivatives	1919	72	....	3,529	87,979
Alcohols:	1919			Gal.	
Ethyl (grain)		1,434	....	2,980,500	14,466,200
Denatured		277	....	796,900	524,000
Methyl (wood)		105	....	73,200	106,100

(a) Includes synthetic preparations in 1919—4 establishments; value $404,585; 1914—75 establishments; value, $1,384,996.
(b) Figures not available.

Natural Dyes and Extracts

The total production of natural dyestuffs in 1919 as reported by all manufacturing establishments was valued at $4,689,000, as compared with $1,862,200 in 1914, and the total production of tanning materials was valued at $32,625,300 in 1919, as compared with a production of $7,898,700 in 1914. In addition the establishments reported the manufacture of mordants to the value of $1,218,700, assistants valued at $2,845,300 and sizes to the amount of $11,580,500.

NATURAL DYESTUFFS AND EXTRACTS, 1919 AND 1914

	1919		1914	
	Quantity, Lb.	Value	Quantity, Lb.	Value
Total	.....	$57,233,000	.....	$21,382,700
Natural dyestuffs and extracts: industry	.....	54,063,000	.....	*20,620,300
Subsidiary products of other industries	.....	3,170,000	.....	762,400
Natural dyestuffs	.....	4,639,000	.....	1,862,200
Logwood extract	32,727,000	3,292,500	28,990,000	1,312,000
Fustic	3,896,000	355,000	4,510,000	222,800
Quercitron	6,746,000	303,400	3,845,000	113,000
Brazilwood and other red woods	1,553,000	246,400	.....	214,400
Cutch	525,000	66,500		
Other	896,000	425,200		
Tanning materials	.....	32,625,300	.....	7,898,700
Oak extract	27,726,000	1,390,100	328,198,000	4,130,100
Chestnut	444,735,000	17,287,700		
Hemlock	19,706,000	879,400	18,978,000	340,400
Sumac	3,507,000	253,100	4,512,000	129,600
Quebracho	71,412,000	7,123,800	.....	3,298,600
Gambier	1,006,000	87,200		
Spruce, myrobalans, dividivi and gallnuts, (chiefly spruce)	81,811,000	804,300		
Other vegetable extracts	34,805,000	3,124,200		
Other tanning materials, including chrome tanning and ground bark	.....	1,675,500		
Mordants	.....	1,218,700	.....	392,400
Assistants	.....	2,845,300	.....	1,537,000
Sizes	.....	11,580,500	.....	3,052,900
Dextrine	49,329,000	3,791,400	18,914,000	705,600
Rosin	57,056,000	2,888,600	20,717,000	373,200
Gums other than rosin	8,672,000	634,600	3,832,000	205,300
Other sizes, starches, glue, etc	.....	4,265,900	.....	1,768,800
All other products	.....	4,274,200	.....	*6,639,500

* Includes artificial dyestuffs to the amount of $5,252,600 included in the industry in 1914.

Fertilizer Industry

In 1919 the establishments in the fertilizer industry proper, 599 in number, were located 144 in Georgia, 50 in South Carolina, 45 each in Maryland and North Carolina, 44 in Virginia, 40 in Alabama, 31 in Pennsylvania, 24 in Florida, 21 in Ohio, 19 in New Jersey, 16 in California, 13 in Indiana, 12 in Illinois, 10 each in Maine and Tennessee, 9 each in Mississippi and Texas, 7 in Delaware, 6 each in Connecticut, Louisiana and New York, 4 each in Kansas and Kentucky, 3 each in Missouri, Oregon and Washington, 2 each in Arkansas, Colorado, Massachusetts and Nebraska, and 1 each in Iowa, Michigan, Montana, Nevada, New Mexico, Rhode Island, and West Virginia.

FERTILIZER INDUSTRY, 1919 AND 1914

	Number of Establishments		Production	
	1919	1914	1919	1914
Total for all establishments	818	1,238	$303,238,000	$169,017,000
Fertilizer industry	599	784	$278,609,000	$153,196,000
Subsidiary products, other industries (a)	219	454	$24,629,000	$15,821,000
Fertilizers, tons	....	....	8,291,000	$8,432,000
Value	....	....	$280,288,000	$153,260,000
Complete and ammoniated, tons	530	898	4,696,000	5,612,000
Value	....	....	$196,343,000	$121,676,000
Superphosphates, tons	250	218	2,340,000	1,693,000
Value	....	....	$44,956,000	$14,779,000
Concentrated phosphates, tons	15	18	117,000	68,000
Value	....	....	$3,755,000	$1,367,000
Other fertilizers, tons	434	461	1,138,000	1,059,000
Value	....	....	$35,234,000	$15,438,000
Fish scrap, tons	51	55	48,600	62,900
Value	....	....	$3,240,700	$1,915,500
Oil, gals	50	48	2,132,300	2,445,000
Value	....	....	$1,850,000	$778,300
Bone black, pounds	8	5	44,598,000	41,055,000
Value	....	....	$2,227,100	$1,413,000
Sulphuric acid (basis 50 deg. Baumé), tons	....	....	309,300	129,100
Value	....	....	$3,639,000	$768,800
Other acids and chemicals	....	....	$711,800	$400,600
Glue	5	12	$2,171,100	$1,131,200
Grease (soap stock, etc.)	....	....	$2,162,200	$1,209,300
All other products	....	....	$6,947,600	$8,140,200

(a) Includes 100 cottonseed oil mills, 51 slaughtering and meat packing plants, and 68 establishments in other industries producing waste of fertilizing value.

Gas Industry

The figures are based on returns from 1,020 establishments, with products for the year valued at $328,851,000. At the census of 1914 there were 1,244 establishments with products valued at $217,920,000, an increase of $111,931,000, or 50.9 per cent. The decrease in number of establishments is chiefly in the small town and village plants of the acetylene or gasoline groups, there being but 37 acetylene and 22 gasoline (cold process) plants in 1919 as compared with 125 and 112 respectively in 1914.

The total production of gas for sale in 1919 was 307,913,000,000 cu.ft., valued at $281,865,000, an average value of 91.5c. per thousand feet. In 1914 the production was 203,517,500,000 cu.ft., valued at $172,748,000, or an average unit value of 84.9c. The increase in quantity was 104,395,500,000 cu.ft., or 51.3 per cent, and in value $109,117,000 or 63.2 per cent.

GAS, MANUFACTURED, 1919 AND 1914

Products*	1919 Quantity	1919 Value	1914† Quantity	1914† Value
Value of products		$328,851,000		$217,920,000
Gas for sale, M. cu.ft	307,903,000	281,865,000	203,517,500	172,748,000
Coal gas	8,029,500	10,496,400	10,509,900	10,726,500
Carbureted water gas	90,656,300	83,663,400	90,017,700	74,516,500
Mixed coal and water gas	179,877,500	161,199,700	86,281,300	72,012,000
Oil gas	15,420,300	18,747,500	16,512,300	15,044,500
Acetylene (distributed through mains)	5,200	59,600	14,900	194,000
Gasoline (cold process gas)	20,400	41,200	181,400	254,700
Other (enrich. nat. gas)	13,903,800	7,647,200	.....	.....
Coke, for sale, tons	2,458,200	17,822,900	2,281,800	8,719,900
Made and consumed	1,820,400	.....	1,300,700	.....
Tar, for sale, gal	120,550,400	4,661,300	125,938,600	3,252,900
Made and consumed	47,639,500	.....	27,372,600	.....
Ammonia, liquor, gal	30,148,500	1,677,200	50,737,800	1,235,400
Ammonium sulphate, lb	5,073,900	205,000	6,216,500	134,200
Other products	.....	5,265,300	.....	20,851,800
Receipts from lamps and appliances	.....	17,354,300	.....	10,977,800
Materials	**Quantity**	**Cost**	**Quantity**	**Cost**
For gas making:				
Coal, anthracite, G.T.	1,307,400	11,326,300	6,116,700	20,872,500
Bituminous, N.T.	6,193,500	32,412,300		
Oil, gals	879,320,800	50,624,900	715,418,600	24,721,000
Coke, purchased, N.T	1,335,300	11,781,900	964,900	4,500,300
Made and used in generators, N.T	663,300	.....	‡	.....
Other materials§	.....	84,600	.....	339,700
Gas purchased, M.cu.ft	82,020,000	22,578,500	28,351,100	8,883,000

* In addition six establishments in 1919 and five in 1914, primarily in other lines of manufacture, distributed gas through mains—1919—64,200 M.cu.ft.; value $112,480; 1914—51,898 M.cu.ft.; value $61,405.

† Not including forty establishments without mains, included in report for gas industry in 1914 (product compressed gas in cylinders—121,696 M.cu.ft., value $2,317,600).

‡ Figures not available.

§ Includes benzene, benzine, gasoline, naphtha and calcium carbide.

Glass Industry

The preliminary report for the glass industry during 1919 was published in Chemical & Metallurgical Engineering, vol. 24, p. 1017, June 8, 1921.

Leather Industry

Reports were received from 681 establishments, having a total output valued at $928,668,200. In 1914 there were 767 establishments with a total value of products amounting to $367,201,700. Of the 681 establishments reported for 1919, 131 were located in Massachusetts, 94 in New York, 92 in Pennsylvania, 73 in New Jersey, 30 in Illinois, 28 in Michigan, 25 in Wisconsin, 24 in Ohio, 21 each in California and Virginia, 18 in Delaware, 17 in West Virginia, 11 in North Carolina, 10 each in Kentucky and Tennessee, 9 each in Indiana and Maine, 7 each in Connecticut, Maryland, Missouri and New Hampshire, 6 in Minnesota, 5 in Oregon, 3 each in Georgia and Texas, 2 each in North Dakota, Rhode Island, Vermont and Washington, and 1 each in Alabama, Colorado, Louisiana, South Dakota and Wyoming.

COMPARATIVE SUMMARY FOR THE LEATHER INDUSTRY 1919 AND 1914

	1919	1914
Number of establishments	681	767
Value of products	$928,668,200	$367,201,700
Leather, value	$848,038,500	$341,796,400
Sole leather, sides	19,715,800	18,075,500
Value	$218,829,900	$116,188,000
Hemlock, sides	1,731,500	5,626,700
Value	$16,179,600	$31,007,400
Union, sides	7,314,900	6,588,800
Value	$79,917,900	$42,457,800
Oak, sides	10,086,200	5,267,900
Value	$117,522,100	$38,384,100
Chrome, sides	583,200	592,000
Value	$5,210,300	$4,338,800
Belting, butts	1,483,070	647,200
Value	$32,777,000	$8,369,600
Harness, sides	2,677,200	2,777,300
Value	$24,171,000	$20,969,200
Upholstery, value	$31,916,700	$14,328,400
Cattle side, upper (other than patent), sides	16,709,500	8,246,000
Value	$120,897,300	$32,939,100
Upper, skins	79,811,900	66,268,800
Value	$266,725,000	$83,009,200
Horse, sides	2,913,200	965,300
Value	$16,181,400	$2,881,900
Fancy, skins	1,783,500	7,486,300
Value	$5,687,100	$6,406,000
Patent, value	$26,754,400	$15,590,800
Glove, value	$16,004,900	$3,286,400
Finished splits, value	$16,501,700	$8,547,200
Case, bag, and strap leather, value	$11,880,800	$5,383,300
Skirting and collar leather, value	$5,998,700	$2,083,000
Bookbinders', value	$3,463,800	$1,362,700
Sold in rough, value	$3,712,700	$4,495,000
All other leather, value	$46,508,600	$15,956,600
Amount received for work done for others	$51,913,800	$12,270,900
All other products	$28,715,900	$13,134,400

Paper and Wood Pulp Industry

Returns were received from 713 establishments engaged in the industry in 1919, with products to the value of $789,548,000. Of the total number, 481 establishments manufactured paper only, 61 wood pulp only, and 171 both paper and pulp. At the census of 1914 there were 718 establishments with products valued at $332,147,000. At the census of 1919 the production of paper amounted to 6,124,000 tons, valued at $682,043,000, as compared with 5,269,000 tons valued at $291,588,000 in 1914, an increase of 16.2 per cent in tonnage and 133.9 per cent in value.

Products	Quantity (Tons of 2,000 Lb.) 1919	Quantity (Tons of 2,000 Lb.) 1914	Value 1919	Value 1914
Wood pulp produced (including that used in mills where manufactured), total	3,519,000	2,893,000		
Ground, tons	1,519,000	1,294,000		
Soda fiber, tons	412,000	348,000		
Sulphite fiber, tons	1,420,000	1,151,000		
Sulphate fiber, tons	120,000	52,000		
Screenings, mechanical, tons	12,000	12,000		
Screenings, chemical, tons	36,000	36,000		
Total value of products*			$789,548,000	$332,147,000
Newspaper, in rolls and sheets	1,324,000	1,313,000	$98,560,000	$52,943,000
Hanging papers	69,000	97,000	6,043,000	4,489,000
Poster, novel, tablet, lining, etc.	80,000	†8,000	7,273,000	†491,000
Book paper:				
Plain	819,000	787,000	118,271,000	58,496,000
Coated paper	132,000	117,000	24,010,000	11,606,000
Plate, lithograph, map, etc.	10,000	9,000	1,556,000	588,000
Cover paper	40,000	22,000	9,531,000	2,809,000
Fine paper	325,000	248,000	87,741,000	34,055,000
Wrapping paper, including bag paper	932,000	882,000	114,936,000	49,373,000
Tag stock (rope, jute, etc.)	27,000	29,000	5,460,000	1,936,000
Boards:				
Wood pulpboard	180,000	116,000	14,888,000	4,227,000
Strawboard	228,000	175,000	12,230,000	4,270,000
Newsboard	89,000	128,000	4,604,000	3,502,000
Binders', trunk and press boards	43,000	61,000	3,788,000	2,664,000
Cardboard, bristol board, card middles, etc	85,000	83,000	11,104,000	5,376,000
Leather board	28,000	27,000	2,263,000	1,177,000
Chip board	714,000	(‡)	37,749,000	(‡)
All other	518,000	701,000	37,464,000	23,652,000
Tissue paper	191,000	115,000	40,696,000	11,536,000
Blotting paper	13,000	14,000	3,209,000	1,458,000
Building paper	195,000	244,000	17,737,000	9,476,000
All other paper	82,000	93,000	16,461,000	7,464,000
All other products, including wood pulp manufactured for sale	.....	.....	113,974,000	40,559,000

* In addition, in 1919, five establishments engaged primarily in the manufacture of other products produced paper and pulp to the value of $1,064,772, and in 1914, nine such establishments manufactured $2,767,407 worth of paper and pulp.

† Reported as poster paper in 1914.

‡ Included in all other boards in 1914.

Paint and Varnish Industries

The figures are based upon the returns from 601 establishments primarily engaged in the manufacture of paints with products valued at $256,714,300, and 229 establishments in the manufacture of varnishes with products valued at $83,632,400. In addition, paints and varnishes to the value of $41,559,300 were manufactured by 56 establishments included under other classified industries.

At the census of 1914 there were 585 establishments in the paint industry with products valued at $112,408,700, 215 in the varnish industry with $33,215,000, and 57 establishments in other classified industries, making paint and varnish to the amount of $3,549,700.

PAINTS AND VARNISHES, 1919 AND 1914

	1919		1914	
	No. of Establishments	Value of Products	No. of Establishments	Value of Products
Total	886	$381,916,000	857	$149,173,400
Paint industry	601	256,714,300	585	112,408,700
Varnish industry	229	83,632,400	215	33,215,000
Paint and varnish subsidiary products of other industries	56	41,569,300	57	3,549,700
	Quantity	Value	Quantity	Value
Colors (pigments)		$72,457,300		$17,450,500
Natural:				
White lead, dry: production, lb	240,052,000		279,269,800	
For sale, lb	80,455,000	6,318,500	71,643,800	3,697,700
Made and consumed, lb	159,597,000		207,626,000	
Zinc oxide, lb	279,321,000	24,082,300	(a)	(a)
Lithopone, production, lb	154,622,300			
For sale, lb	151,200,700	9,757,600	48,972,900	1,857,500
Made and consumed, lb	3,421,600		(a)	
Lead oxides, production, lb	165,106,700		61,335,300	
For sale, lb	162,474,200	12,748,400	58,642,600	3,281,700
Made and consumed	2,632,500		2,692,700	
Iron buff and other earth colors, lb	189,347,000	3,657,900	92,897,000	797,800
Chrome yellow, lb	2,307,700	612,300	6,747,300	641,500
Orange or green, lb	2,985,700	666,700	8,024,400	677,300
Prussian blue, lb	627,200	457,500	1,239,400	387,100
Ultramarine, lb	2,800,000	630,000	2,698,600	222,800
Vermilion (true), lb	327,500	237,800	322,760	200,100
Fine colors (n.e.s.), lb	3,881,200	1,754,100	4,215,900	690,300
Other dry colors, lb	78,259,000	5,984,300	142,537,000	3,942,400
Pulp colors, sold moist, lb	30,084,300	3,262,300	22,110,500	1,054,300
Synthetic:				
Chrome yellow, orange or or green, lb	4,138,470	802,400		
Iron, buff and other iron colors or dyes, lb	12,834,500	121,000	(b)	(b)
Prussian blue, lb	317,450	187,700		
Other mineral colors, lb	38,264,000	1,176,500		
Paints in oil		168,525,400		70,582,400
In paste form: White lead	237,358,700	25,606,600	281,417,600	18,141,500
Other paints, lb	160,910,000	23,576,600	138,594,500	10,896,700
Mixed for use, gal	59,646,800	119,342,200	40,745,600	41,445,300
Varnishes and japans		86,814,800		36,142,200
Oleoresinous varnishes, gal	28,116,200	40,044,900	17,801,440	18,762,400
Spirit varnishes, not turpentine, gal	2,974,100	8,105,500	2,964,170	3,080,400
Damar and similar turpentine and benzine varnishes, gal	6,356,400	10,273,800	3,297,370	2,865,300
Pyroxylin varnishes, gal	500,060	923,500	852,570	1,308,800
Drying japans and driers, gal	5,940,970	5,558,900	6,560,400	3,015,900
Baking japans and lacquers, gal	5,375,220	5,877,600	4,888,800	2,960,800
Other, gal	11,318,200	16,030,600		4,148,600
Fillers		6,551,600		3,239,200
Liquid fillers, gal	2,605,280	1,835,600	965,640	670,100
Paste or dry fillers, lb	16,981,500	1,551,800	49,587,550	1,318,700
Putty, lb	66,681,500	3,164,200	69,828,000	1,250,400
Water paint and kalsomine		5,351,900		2,202,300
Dry or in paste, lb	106,797,920	4,549,100	61,904,260	2,055,200
Mixed for use, gal	359,130	802,800	297,170	147,100
Other products:				
Bleached shellac, lb	8,799,190	5,955,700	8,654,510	1,806,800
Boiled linseed oil, gal	611,130	1,044,800	572,560	306,600
All other products		35,214,500		17,443,400
Principal materials:		Cost		Cost
Pig lead, short tons	147.012	17,241,730	150.762	11,488,110
Alcohol, grain, gal	2,985,740	1,724,100	1,061,300	436,500
Alcohol, wood, gal	244,560	304,000	987,450	422,100
Linseed oil, gal	26,385,230	42,660,000	24,481,620	12,049,200
Chinawood, soya and other oils, gal	17,770,380	17,199,400		
Turpentine, gal	6,081,900	6,962,000	(a)	(a)
Benzene, gal	1,665,600	400,200		
Rosin, lb	85,886,500	5,409,300		
Shellac, lb	7,785,300	4,653,600	48,902,000	4,797,900
Other gums, lb	35,352,200	5,123,400		

(a) Figures not available. (b) Not separately reported; included above.

Petroleum Refining

With reference to the petroleum refining industry reports were received from 318 establishments with products for the year valued at $1,632,354,000. At the census of 1914 there were 176 establishments with products valued at $396,361,400, an increase of $1,235,992,000 or 312 per cent.

The phenomenal increase is the result of increase in quantity production and in higher unit values. The output of gasoline in 1919 was 3,637,045,000 gal., valued at $679,775,500 as compared with 1,195,412,000 gal., and $106,140,200 in 1914, an increase of 204 per cent in quantity and 540 per cent in value, and in unit value from 8.8c. to 18.7c. Likewise in fuel oils: the output in 1919 was 7,979,868,000 gal. valued at $318,082,700 as compared with 3,734,092,000 gal. valued at $84,017,800 in 1914, an increase of 114 per cent in quantity, and 277 per cent in value, and in unit values from 2.25c. to 4c.; and in illuminating oils the production in 1919, 2,304,850,000 gal. valued at $235,617,500 was an increase of 19.1 per cent in quantity and 143 per cent in value over that of 1914, with an increase in unit values from 5c. to 10.2c.

The refineries used 357,686,000 bbl. of crude petroleum (domestic 319,626,600 bbl., foreign 38,059,400 bbl.) in 1919, costing $866,265,000, as compared with 191,262,700 bbl. (185,027,479 domestic and 6,235,245 foreign) and $249,728,000 in 1914, an increase of 87 per cent in quantity and of 247 per cent in cost, and in increase in unit values from $1.31 to $2.42 per bbl. The marketed production of crude petroleum in 1919 was 377,719,000 bbl., and in 1914, 265,762,535 bbl. Thus the refinery consumption was equal to 84.6 per cent of the domestic production in 1919 as compared with 69.6 per cent in 1914 and 65.9 per cent in 1909.

The gasoline product of the refineries does not include casing-head gasoline made at the wells, except to the extent that it was purchased and used as a material (6,952,200 bbl.). The ranking states, those with products in excess of $100,000,000, are New Jersey, with 9 establishments; Texas, 38; California, 45; Pennsylvania, 53; and Oklahoma, 66.

Comparative data for the industry in 1919 and 1914 are tabulated in the following table:

PETROLEUM REFINING 1919 AND 1914

Products	1919 Quantity 1,000 Gal.	1919 Value	1914 Quantity 1,000 Gal.	1914 Value
Value of products		$1,632,354,000		$396,361,400
Naphthas and lighter products	4,190,276	765,914,500	1,460,038	121,919,300
Gasoline	3,637,045	679,775,500	1,195,412	106,140,200
Naphtha	392,257	65,077,900		
Benzine	64,491	10,015,900	264,626	15,779,100
Other	96,483	11,045,200		
Illuminating oils	2,304,850	235,617,500	1,935,275	96,806,500
Fuel oils:				
Distillates	635,900	36,548,100	457,492	15,999,300
Gas oils	1,259,943	76,383,500	755,558	22,805,300
Residual fuel oils	6,084,025	205,151,100	2,521,042	45,213,200
Lubricating oils	818,953	196,242,400	517,839	55,812,100
Pale or paraffin	123,373	28,238,300	93,422	8,084,600
Red or neutral	210,516	44,583,100	116,353	12,426,000
Cylinder	235,436	59,036,500	102,949	13,703,800
Other	249,504	64,384,500	205,115	21,597,700
Liquid asphaltic road oils	97,037	4,480,700	134,844	4,018,000
Residuum or tar	29,163	1,533,500		
Partly refined oils sold for rerunning	428,347	29,268,900		(a)
Grease		11,896,700		3,536,500
Petroleum, mineral jelly, etc	10,230	3,750,000	6,078	1,243,400
Lubricating greases	12,599	6,043,800	4,980	1,625,000
Axle greases	5,318	2,102,900	2,948	668,100
Paraffin wax	69,361	28,348,400	57,539	8,897,000
Candles		2,939,500		1,403,000
Asphalt other than liquid	(b) 927,151	12,500,200	(b) 465,157	4,867,200
Coke	(b) 798,180	3,928,300	(b) 213,777	818,900
Reclaimed acid sold (66 deg.)	(b) 136,320	687,300	(b) 89,792	491,400
Acid oil	45,600	992,900		
Other special products		6,813,600		8,508,000
All other products		13,106,900		5,265,700

Materials	Quantity (Bbl. 42 Gal.)	Cost	Quantity (Bbl. 42 Gal.)	Cost
Crude petroleum	357,686,000	$866,265,000	191,262,700	$249,728,000
Penn. grade	29,838,500	126,182,000	21,197,000	50,020,000
Lima—Indiana	1,737,800	5,031,600	2,564,700	4,286,600
Illinois	15,580,000	33,469,300	17,672,300	30,138,000
Mid-continent	171,704,500	495,812,200	92,462,600	121,188,500
Gulf	16,399,600	28,918,800	5,787,300	6,080,900
California	71,529,700	106,360,500	41,901,700	30,157,000
Rocky Mt. and other U.S.	12,836,500	21,666,000	3,441,900	2,088,700
Foreign (Mexican, etc.)	38,059,400	48,824,600	6,235,200	5,768,300
Distillates purchased and re-run	30,465,400	98,757,000	9,455,300	24,395,500
Casing-head gasoline purchased	6,952,200	58,592,000	.....	(a)
	1,000 cu.ft.			
Casing-head gas	16,671,322	1,254,400	.....	(a)

PRODUCTION OF PETROLEUM IN THE UNITED STATES, 1919
(U. S. Geol. Survey)

Total, bbl.	377,719,000	Mid-continent	196,891,000
Appalachian (Penn. grade)	29,232,000	Gulf	20,568,000
Lima—Indiana	3,444,000	California	101,564,000
Illinois	12,436,000	Rocky Mountain	13,584,000

(a) Figures not available.
(b) Tons (2,000 pounds).

Rubber Goods Industry

Reports were received from 475 establishments in the rubber goods industry having a total value of products of $1,138,216,000. In 1914 there were 342 establishments with a total value of products of $300,994,000. Of the 475 establishments reported by the rubber industry in 1920, 96 were located in Ohio; 73 in New Jersey; 56 in Massachusetts; 43 in New York; 32 in Pennsylvania; 26 in Connecticut; 22 in California; 21 in Illinois; 16 in Indiana; 10 in Rhode Island; 9 each in Iowa and Wisconsin; 8 each in Missouri and Oklahoma; 7 in Michigan; 6 in Texas; 4 each in Colorado and Washington; 3 each in Georgia, Kansas, Missouri and Nebraska; 2 each in Maryland, North Carolina, Oregon, West Virginia and Delaware; and 1 each in Louisiana, Kentucky and Maine.

RUBBER GOODS INDUSTRY, 1919 AND 1914

	1919	1914
Number of establishments	475	342
Value of products (a)	$1,138,216,000	$300,994,000
Tires:		
Pneumatic:		
Automobile:		
Casings, number	22,727,000	8,022,000
Value	$485,904,000	$105,679,000
Inner tubes, number	39,700,000	7,908,000
Value	$199,305,000	$20,101,000
Motorcycle and bicycles:		
Casings, number	3,422,000	.....
Value	$11,892,000	3,728,000
Inner tubes, number	1,393,000	(c) $6,906,000
Value	$2,904,000	.....
Solid:		
Truck, number	1,620,000	.....
Value	$43,917,000	
All other, number	6,635,000	(c) $13,736,000
Value	$9,005,000	.....
Boots and shoes:		
Rubber boots, pairs	9,208,000	4,025,000
Value	$26,067,000	$12,648,000
Rubber shoes and overshoes, pairs	66,195,000	57,212,000
Value	$64,713,000	$37,858,000
Canvas shoes with rubber soles, pairs	19,896,000	.....
Value	$25,177,000	(b)
Heels (includes only those sold as such or on hand), pairs	126,572,000	.....
Value	$14,238,000	(b)
Soles, including composition or fiber, pairs	18,437,000	.....
Value	$4,321,000	(b)
Rubberized fabrics:		
Automobile and carriages, yards	14,429,000	.....
Value	$10,697,000	(b)
All other, yards	17,630,000	.....
Value	$13,712,000	(b)
Belting, value	$22,436,000	$7,989,000
Hose, value	$26,998,000	$16,854,000
Packing, value	$7,317,000	$3,508,000
Clothing, value	$10,450,000	$6,799,000
Druggists' and stationers' sundries, value	$13,834,000	$7,512,000
Hard rubber goods, value	$34,230,000	(b)
All other manufactures of rubber, value	$80,720,000	(d) $40,133,000
Reclaimed rubber (produced and sold as such or on hand), pounds	121,795,000	(b)
Value	$23,716,000	$11,135,000
All other products, value	$6,663,000	$10,136,000

(a) In addition, in 1919, products to the value of $7,574,000 were reported by establishments assigned to other classifications, and in 1914 to the value of $752,503.
(b) Not reported in 1914.
(c) Not segregated in 1914 (number of solid tires not shown).
(d) Includes scrap and old rubber (sold or on hand).

Soap Industry

Returns were received from 349 establishments which manufactured soap valued at $317,163,000. In addition soap products to the value of $21,140,000 were produced as subsidiary products by 90 establishments in other lines of manufactures, making a total of $338,303,000. At the census of 1914 there were 371 establishments with products valued at $127,942,000 and 142 establishments with subsidiary soap products to the value of $7,362,000, a total of $135,304,000. Although the industry shows a decrease in the number of establishments for 1919 as compared with 1914, the increase in the value of products for all establishments was $202,999,000 or 150 per cent, primarily due to higher prices.

SOAP INDUSTRY, 1919 AND 1914

	1919	1914
Number of establishments	439	513
Soap industry	349	371
Subsidiary soap products, other industries	90	142
Value of products	$338,303,000	$135,304,000
Soap industry	317,163,000	127,942,000
Subsidiary soap products	21,140,000	7,362,000
Hard soaps, lb.	2,322,185,000	2,064,228,000
Value	$227,439,000	(a) $104,465,000
Toilet soaps, lb.	179,256,000	169,926,000
Tallow soaps, lb.	945,414,000	938,447,000
Olein soaps, lb.	110,785,000	42,524,000
Powdered soaps, lb.	466,541,000	367,744,000
Soap chips, lb.	182,738,000	97,746,000
Foots soap, lb.	16,191,000	
Dye soaps, lb.	21,710,000	447,841,000
Other hard soaps, lb.	399,550,000	
Soft soap, lb.	75,307,000	57,002,000
Value	$3,962,000	$1,697,000
Liquid soap, lb.	10,025,000	.....
Value	$1,254,000	.....
Special soap articles, value	$3,568,000	$833,000
Lye, lb.	16,301,000	23,346,000
Value	$1,789,000	$891,000
Glycerine:		
Crude, lb.	18,258,000	12,745,000
Value	$2,483,000	$1,817,000
Refined, lb.	44,377,000	32,674,000
Value	$11,461,000	$5,776,000
Perfumery and toilet preparations, value	$12,635,000	$6,804,000
All other products, value	$73,712,000	$13,021,000

(a) Value of hard soaps 1914, not distributed by kind.

Sugar Industry

Figures for the beet and cane sugar industries during 1919 were given in CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 1017, June 8, 1921.

Brass, Bronze and Copper Products

Of the 1,119 establishments which reported the manufacture of brass, bronze and copper products during 1919, 213 were located in New York, 125 in Ohio; 122 in Pennsylvania; 88 in Illinois; 80 in Michigan; 75 in Connecticut; 72 in Massachusetts; 67 in New Jersey; 44 in California; 36 in Wisconsin; 31 in Indiana; 21 in Missouri; 20 in Maryland; 18 in Rhode Island; 16 in Washington; 10 in Minnesota; 9 each in Kentucky and Colorado; 7 in Texas; 6 each in Louisiana and New Hampshire; 5 each in Iowa and Maine; 4 each in Alabama, Delaware, Georgia and Oregon; 3 each in Nebraska and West Virginia; 2 each in Montana, Tennessee, Utah and Virginia; 1 each in the District of Columbia, Florida, Kansas and Vermont.

BRASS, BRONZE AND COPPER PRODUCTS, 1919 AND 1914

	1919	1914
Number of establishments	1,119	992
Value of products	$487,707,000	$162,199,000
Ingots and bars	30,490,000	4,792,000
Plates and sheets	102,898,000	41,655,000
Rods	40,705,000	17,189,000
Tubing:		
Seamless	37,531,000	10,269,000
Brazed	4,603,000	3,646,000
Wire:		
Plain	33,933,000	13,487,000
Insulated	3,694,000	846,000

	1919	1914
Castings and machinery fittings	$130,736,000	(a) $5,288,000
Lamps	1,559,000	561,000
Electrical supplies	7,927,000	1,127,000
Other hardware and trimmings	38,396,000	1,524,000
Other manufactured products	15,400,000	19,430,000
All other products	33,961,000	47,385,000
Amount received for custom work and repairing	5,874,000	(b)

(a) Includes aluminum castings only in 1914.
(b) Included with "all other" products in 1914.

Pig Iron Industry

The following figures for the pig iron industry are based upon the returns from 195 establishments with products valued at $794,466,600. In addition pig iron to the value of $6,595,800 was produced by 5 establishments included under other classified industries, making a total of 200 establishments, and $801,062,300 in products. At the census of 1914 there were 160 blast-furnace establishments with products valued at $317,654,000.

PIG IRON INDUSTRY, 1919 AND 1914

	1919		1914	
Number of establishments	(a) 200		160	
	Quantity, Gross Ton	Value	Quantity, Gross Ton	Value
Products				
Total value		$801,062,300		(b) $317,654,000
Blast furnaces—Pig iron industry		794,466,500		317,654,000
Subsidiary pig iron products, other industries		6,595,800		
Pig iron	30,543,167	785,960,400	23,269,731	312,761,600
For consumption in works of company producing	21,687,376	523,533,000	15,495,004	209,263,400
For sale	8,855,791	262,427,400	7,774,727	103,498,200
All other products		15,101,900		4,892,400
Pig iron by fuels:				
Coke	30,097,220	770,101,200	22,787,890	304,234,200
For consumption	21,686,861		15,436,921	
For sale	8,410,359		7,350,969	
Bituminous coal and coke	35,745	1,385,600	118,632	2,704,100
Ant. and ant. and coke	94,465	2,975,500	87,919	1,256,600
Charcoal	315,737	11,498,100	275,290	4,444,700
Pig iron by grades:				
Basic	14,597,535		9,465,853	
Bessemer	9,374,950		7,577,792	
Low phosphorus	289,726		305,738	
Foundry	4,792,961		4,325,100	
Malleable	1,090,344		730,910	
Forge or mill	287,529		488,172	
White, mottled and misc.	56,418		32,202	
Direct, chstings	53,704		14,384	
Delivered molten to steel works, etc.	18,138,453		11,936,791	
Machine cast	7,746,656		6,007,417	
Sand cast	3,970,309		4,681,867	
Chill cast	634,045		629,272	
Direct castings	53,704		14,384	
Materials		**Cost**		**Cost**
Iron ore	56,333,358	310,981,100	43,326,817	150,855,700
Domestic	55,792,776	306,623,000	41,556,642	141,276,700
Foreign	540,582	4,358,100	1,770,175	9,579,000
Scrap, mill cinder, etc.	3,436,851	23,273,400	2,168,092	6,651,100
Fluxing material, net tons	15,599,824	25,722,400	11,499,685	11,184,400
Fuel for smelting		229,111,300		85,436,500
Coke, net tons	34,605,700	223,250,600	26,883,082	83,499,400
Charcoal, bushels	31,931,134	5,684,200	29,083,978	1,683,100
Anthracite	25,153	104,300	38,874	158,400
Bituminous coal, net tons	23,568	72,200	60,337	95,600

(a) Includes 5 establishments in other lines of manufacture (ferro-alloys, etc.) producing 265,876 tons of pig iron, valued at $6,595,800.
(b) Includes ferro-alloys (329,580 tons) not included in the pig iron industry in 1919.

Industrial Power and Fuel Consumption in Superpower Zone

A preliminary statement with respect to power equipment and fuel consumption of plants in the Superpower Zone has been prepared by the Bureau of the Census in collaboration with the Superpower Survey of the United States Geological Survey.

The Superpower Zone embraces the North Atlantic area from Maryland to New Hampshire and includes in entirety, Connecticut, Massachusetts, Rhode Island, New Jersey, and the District of Columbia; the southern portion of New Hampshire (Cheshire, Hillsboro, Merrimac and Rockingham counties); the southern portion of Vermont (Bennington and Windham counties); Kent and New Castle counties in Delaware; Anne Arundel, Baltimore, Baltimore City, Cecil, Herford, Kent, Prince Georges and Queen Annes counties in Maryland; the eastern portion of Pennsylvania extending west to York, Dauphin, Northumberland, Montour, Columbia, Luzerne, Wyoming and Susquehanna counties inclusive; and the southeastern portion of New York, extending west and north to Broome, Delaware, Otsego, Oneida, Herkimer, Fulton, Saratoga, Warren and Washington counties. The superpower project contemplates the development of available water powers to supplement and equalize power requirements, and effect economies in fuel consumption.

The figures are based upon returns from 95,984 establishments. Of these 76,277 or 79.4 per cent used power, the same including 73,694 manufactories, 1,563 laundries, 939 mines and quarries and 31 governmental institutions. The power equipment of these 76,227 establishments aggregated 9,069,471 hp., comprising the following factors:—33,379 steam engines of 4,255,868 hp., 2,115 steam turbines of 1,171,061 hp., 6,246 internal-combustion engines of 279,040 hp., 4,708 waterwheels of 541,033 hp., 506,907 electric motors of 5,336,627-hp. rating (of which 361,961 of 2,770,715 hp. were operated with purchased energy and 198,946 of 2,565,912 hp. by current generated by the establishment), and 51,754 hp. of purchased power other than electric.

The net total is 9,069,471 hp. of rated power equipment, primary and purchased, of which 5,336,627 hp. or 58.8 per cent is represented, as utilized, by electric motor equipment. These establishments consumed 20,910,000 long tons of anthracite, 34,669,000 short tons of bituminous coal and 5,661,000 tons of coke.

INDUSTRIAL POWER AND FUEL CONSUMPTION IN SUPERPOWER ZONE, 1919

A—Power equipment, by types:

Class	Number of Units	Horsepower
Aggregate	.....	9,069,471
Prime movers	.....	6,247,002
Steam engines	33,379	4,255,868
Steam turbines	2,115	1,175,061
Internal combustion engines	6,246	279,040
Water wheels	4,708	541,033
Operated by purchased energy	.....	2,822,469
Electric motors	361,961	2,770,715
Other	.....	51,764
Electric motors, total	560,907	5,336,627
Run by current generated in establishment	198,946	2,565,912
Run by purchased current	361,961	2,770,715

B—Horsepower and fuel, by industries:

Industries	No. of Establishments Using Power	Horsepower—Aggregate	Horsepower—Prime Movers	Fuel—Purchased Energy	Fuel—Anthracite Coal, Long Tons	Fuel—Bituminous Coal and Coke, Short Tons
Total	76,227	9,069,471	6,247,002	2,822,469	20,909,865	40,330,352*
Manufactories:						
Textiles and their products	18,442	1,914,722	1,440,495	474,227	1,763,425	5,121,985
Iron and steel	6,362	1,745,755	1,175,504	570,251	1,311,943	10,224,543
Paper and printing	8,291	706,429	489,775	216,653	765,259	1,967,594
Chemicals and allied products	2,109	523,849	390,558	133,291	3,304,186	9,923,865
Metals, non-ferrous	3,423	405,249	245,774	159,475	883,861	1,545,733
Food and kindred products	11,465	385,184	232,084	153,100	1,515,826	1,793,073
Stone, clay and glass	2,204	345,018	229,351	115,667	556,984	3,176,078
Lumber and its remanufactures	4,710	280,533	206,405	74,128	86,481	356,122
Leather and its products	2,707	178,081	104,461	73,620	147,355	650,396
Railroad repair shops	316	119,906	68,549	51,357	435,866	835,468
Liquors and beverages	1,303	113,934	101,762	12,172	345,088	401,199
Vehicles	3,862	95,380	28,222	67,158	107,669	238,864
Tobacco	567	15,334	8,773	6,561	39,529	40,915
Miscellaneous	7,933	1,071,524	546,110	525,414	844,982	3,142,086
Laundries	1,563	55,087	44,371	10,716	178,569	239,132
Mines and quarries	939	1,810,757	857,273	153,484	8,598,467	266,118
Governmental institutions	31	102,729	77,534	25,195	24,375	407,181

* Bituminous coal 34,669,324 tons; coke, 5,661,028 tons.

Microscopic Examination of Iron and Steel

A COMMITTEE on metallography, appointed by the American Society for Testing Materials, has proposed the following tentative methods for testing iron and steel. Criticism of the methods is invited; it should preferably be addressed to G. F. Comstock, Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

Location of Test-Pieces

The location of the test-piece for microscopic examination is of prime importance. In the case of a casting of steel or cast iron, the section ought to be cut perpendicular to the surface so as to show the variation of structure from the outside to the interior. In the case of forged and rolled metal both cross and longitudinal sections should be examined, their location being determined by the nature of the forging, etc. For crankshafts definite locations are given with reference to the tensile test specimens. For guns, tangential specimens are required and for microstructure these should be cut parallel to the axis, etc. No one specimen is of necessity representative. The usual method of taking a cross-section from rods and bars, while showing segregation of the constituents, fails to reveal the usual lamination, for which a longitudinal section is necessary.

In defective material, the sample should be cut adjacent to the fracture or defect. When necessary the fracture can be protected during grinding and polishing by coating it with a heavy deposit of electrolytic copper, molten lead-tin solder or a mixture of litharge and glycerine. For hardened steel and other material likely to be tempered, fusible metals such as Rose's or Wood's alloys may be used.

Method of Polishing

The method used for polishing specimens will depend primarily on the material to be examined and on the polishing equipment. In general, samples should not be over 1-in. square and their thickness should be less than the smallest dimension of the polished surface; otherwise there is a tendency to round off the edges.

The softer material can be cut with a saw, while harder metal may be cut with an emery disk or broken off with a hammer. A flat surface is at first obtained either by rubbing on a file held in a vise or by grinding on an emery wheel. In both cases it is necessary to avoid tearing the surface of the metal or causing it to flow. Perfectly smooth surfaces can be obtained by commercial surface-grinding machines.

Having obtained a flat surface in this way, the sample is next rubbed down on a series of emery papers, usually starting with No. 00 Commercial followed by Nos. 0 and 00 French Emery. (Of course, other similar papers of domestic manufacture are also available and suitable for this purpose.) These papers may conveniently be mounted on revolving disks. Rubbing on one paper is stopped as soon as the scratches from the last operation have been taken out. From the No. 00 French Emery the specimen may be taken to a revolving disk covered with broadcloth, preferably running in a horizontal position at such a speed that the polishing powders are not unnecessarily thrown off. For ordinary work, two such disks will be sufficient, the first armed with well-washed carborundum, 65 or a similar grade, while the second may be armed with well-washed alumina. This is cleaner and better than rouge.

To obtain a fine polish it is a mistake to try to save time by hurrying through the papers because if this is done when the specimen is etched innumerable fine lines will be revealed in the ferrite. In some cases the appearance of the ferrite is actually blurred because the metal distorted in the grinding and by the coarse grades of emery has not been subsequently removed. Under no conditions should buffing be tried, because this causes an actual flow of the metal.

For material of small size, such as sheet and wire, numerous methods of mounting have been devised. For wire, various mounting media such as wax, a mixture of litharge and glycerine, fusible metals and the like can be used in a small brass container. For sheet metal, a pack can be built up of pieces of the sample with alternate layers of red fiber board, bakelite or other resistant material, the whole held together by two brass end pieces and two screws.

Methods of Etching[1]

The sample ought to be examined as polished in order to show up the non-metallic inclusions as well as cracks and other defects. In order to show up the structure of the metallic matrix various etching reagents have been used depending on the material being examined. The accompanying list gives the best of these reagents. For general work a 4 per cent solution of picric acid in ethyl alcohol is recommended. This darkens the pearlite in steel and leaves the ferrite or cementite bright as the case may be. Long etching with picric acid in alcohol will develop the grain structure in very low-carbon steel and in wrought iron. This may be done more rapidly with a 2 to 4 per cent solution of nitric acid in ethyl alcohol (95 per cent). For showing up pearlite alone, picric acid in absolute alcohol is best.

To distinguish between ferrite and cementite in high-carbon steels the usual method is to boil in the sodium picrate solution, which darkens the cementite.

For hardened and tempered steel, picric acid may be used. but after etching, washing under the tap and flooding with alcohol, the specimen should be dried by an air blast or if this is not available by shaking it in air. If the usual method of mopping on a soft towel be tried, the etching film will be spoiled.

For the study of hardened and tempered steels under high magnifications other reagents have been devised, such as those of Kourbatoff.

For distinguishing between cementite and phosphide of iron in cast iron, either heat tinting or boiling with sodium picrate may be used, as recommended by Matweieff. This attacks the iron phosphide, but leaves the cementite unattacked.

For revealing the segregation of the phosphorus in steel, various reagents have been used depending on the deposition on copper from a copper chloride solution, as given in the accompanying list of reagents.

In many cases after etching, the ferrite or cementite may be found to be more or less stained or colored. This can often be remedied by a light repolish on a chamois-skin pad. While this brightens up the ferrite or cementite, as the case may be, it markedly alters the appear-

[1]Sauveur, "Metallurgy and Heat-Treatment of Iron and Steel," 1920, pp. 42 and 62. Tiemann, *Iron and Steel*, 1919, p. 286. Hoyt, *Metallography*, vol. 1, p. 63 (1920). Wawrziniok, "Handbuch des Materialprüfungswesens," p. 497. Czochralski, *Stahl und Eisen*, II, p. 1073, p. 1129 (1915). List of reagents, p. 1132. Goerens, *Metallography*, p. 134. Kerns, Foundry Data Sheets, June 1 and 15, 1920; Etching Solutions for Iron and Steel. Kourbatoff, *Revue de Metallurgie*, vol. 2, p. 169 (1905); Contribution a l'Etude Metallographique des Aciers Trempes. Kourbatoff, *Revue de Metallurgie*, vol. 3, p. 648 (1906). Pamphlet No. 403, U. S. N. Bureau of Ordnance, October, 1916.

ance of the pearlite, giving it an abnormal structure, and therefore when this method is used, photographs should be so marked.

Reagents for Normal Iron and Steel

Picric Acid (Igevsky): Solution (*a*), 4 g. picric acid in 95 c.c. absolute ethyl alcohol. Solution (*b*), 5 g. picric acid in 100 c.c. 95 per cent ethyl alcohol.

Nitric Acid: 5 c.c. concentrated HNO_3 in 95 c.c. 95 per cent ethyl alcohol.

Iodine: 1.25 g. I, 1.25 g. KI, 1.25 c.c. H_2O in 100 c.c. alcohol.

Hydrochloric Acid, recommended by Martens and Heyn (1904) especially for hardened steel: 1 c.c. HCl of specific gravity 1.19 in 100 c.c. alcohol. This may be diluted with 500 c.c. water for electrolytic etching with a very weak current.

Kourbatoff's Solutions for Hardened Steel

Solution A: 4 c.c. HNO_3 in 96 c.c. amyl alcohol, acting five minutes, will color troosto-sorbite brown, austenite yellow, martensite white.

Solution B differentiates the various constituents. It consists of 1 volume of saturated solution of ortho-nitrophenol in alcohol, and 2 volumes of 20 per cent HCl in amyl alcohol.

Solution C: Mix just before using a solution of 4 per cent HNO_3 in acetic anhydride with three times the volume of a mixture of equal parts of amyl, ethyl and methyl alcohols. It colors troostite and troosto-sorbite.

Solution D: 1 volume of 4 per cent HNO_3 in ethyl alcohol plus 3 volumes saturated solution of nitrophenol in ethyl alcohol; immersion of ten minutes colors troosto-sorbite and martensite needles.

Solution E for troostite: 2 parts methyl alcohol, 2 parts ethyl alcohol, 2 parts amyl alcohol, 1 part butyl alcohol, 3 parts of 4 per cent HNO_3 in acetic anhydride.

Solution F: 4 per cent HNO_3 in methyl alcohol to which $\frac{1}{10}$ of its volume of 4 per cent picric acid in ethyl alcohol is added. Colors austenite, martensite and troosite differently.

Solution G: 1 volume of HNO_3 in alcohol and 3 volumes of saturated solution of nitraniline. Colors troostite, troostosorbite and martensite needles.

Benedicks' Solution: 5 per cent meta-nitrobenzol sulphonic acid in alcohol. Darkens martensite more than austenite after immersion of fifteen seconds.

Solutions for Carbides

Kourbatoff: 2 g. picric acid, 25 g. NaOH, 75 c.c. water. Cementite will be colored after boiling five to ten minutes. Ferrite and tungsten carbide (WC) are unattacked. Various other compounds, such as Fe_nW and Fe_2W_2C, are colored.

Matweieff: Boil specimen twenty minutes in a neutral solution of sodium picrate, and wash thoroughly. Iron phosphide is attacked, but cementite is not.

Yatsevitch: Tungsten carbide in high-speed steel is darkened by immersing ten to twelve minutes in a fresh mixture of 10 c.c. commercial H_2O_2 in 20 c.c. of a 10 per cent water solution of NaOH.

Hilpert and Colver-Glauert: Non-pearlitic steels and pig iron may be etched for from seven seconds to one minute in 3 or 4 c.c. saturated aqueous solution of SO_2 in 100 c.c. alcohol or water.

Murakami: Carbide and tungstide in high-speed and tungsten steels may be distinguished by a hot solution of 10 g. potassium ferricyanide, 10 g. KOH and 100 c.c. water.

Solutions for Alloy Steels

Austenitic nickel steels may be etched in 5 g. Fe_2Cl_6, 50 c.c. HCl and 100 c.c. H_2O.

Stellite and high-chromium steels may be etched with a very weak electric current in a 0.5 per cent NaOH solution.

On 110-volt circuit use two 4-cp. lamps in series, connected with two-wire terminal (platinum wire preferable). Flood surface of specimen with solution, and make contact with one wire at side and dip the other in the solution, moving it around to obtain uniform etch.

Methods for Identification of Non-Metallic Inclusions

Stead[2] uses 30 per cent H_2SO_4. Bubbles arise from sulphides, but none from silicates or oxides.

Law[3] uses an acid solution of lead or cadmium salt in gelatine. The sulphides form deep brown or yellow stain of cadmium or lead sulphide. Oxides or silicates unaffected.

MEANS FOR THE IDENTIFICATION OF NON-METALLIC INCLUSIONS

As Polished	
FeS.	Brownish yellow.
MnS.	Slate blue, smooth.
FeS_xMnS_y	Slate blue to brown, may show duplex structure.
FeO.	Slate blue, rough, a little darker than MnS.
MnO.	Similar.
Mn—silicate.	Greenish tinge, smooth and greasy.
Fe—silicate.	Black and greasy.
Al_2O_3.	Tiny hard rounded grains, never elongated by rolling, etc.
Sand grains.	Angular form, convex side, greasy appearance standing in high relief.
Titanium nitride or cyanonitride.	Pink or yellow cubic crystals.

He also recommends as an electrical etching solution consisting of distilled water with 0.002 per cent ammonium chloride or caustic potash, used boiling. After a few minutes wash and dry with alcohol. Results: MnS unaltered. FeO and FeO_xMnO_y is reduced, but MnO unaffected.

Matweieff[4] uses hydrogen or steam at 600 deg. C., or organic acids to distinguish oxides, silicates and sulphides as follows:

	Oxides	Silicates	Sulphides
Hot hydrogen	Reduced	Unaffected	Unaffected
Hot steam	Attacked	Unaffected	Unaffected
Organic acids	Unaffected	Unaffected	Attacked
2% HF in absolute alcohol[5]	Unaffected	Darkens	Darkens

Iron oxide may be distinguished from manganese oxide by repolishing the sample reduced by hot hydrogen, and etching with dilute solution of $FeCl_3$ in alcohol. If colored feebly, the inclusion is FeO; if colored deeply, it is MnO with some FeO; MnO alone is not reduced. Iron sulphite is colored by tartaric acid, while MnS is very feebly colored.

Sulphides

Rohl[6] recommends a 1 per cent solution of acetic, citric, oxalic or picric acid in water, noting that picric acid gives the most uniform results on sulphides. FeS is always readily blackened in one minute; MnS is slightly blackened in forty-five seconds. Sulphides also give a dark brown color after a triple etching (*a*) 4 g. picric acid in 100 c.c. amyl alcohol, (*b*) 4 c.c. HNO_3 in 100 c.c. amyl alcohol, (*c*) concentrated hot NaOH. A 2 per cent sodium acetate will give FeS a brownish tint in one minute, whereas MnS is colored but very lightly.

Reduction tests for sulphides: Sulphides are covered by mercury after immersion in $HgCl_2$ solution. If the sample is lightly repolished, FeS will be found corroded but MnS not. A 3 per cent boiling solution of $AgNO_3$ will color FeS a uniform violet blue and MnS a slightly darkened dove gray. On repolishing, FeS appears a reddish violet, and MnS a blue gray.

Campbell's method of distinction: A short preliminary etching with 1 per cent picric acid in ethyl alcohol, followed by tempering to dark yellow, changes FeS into a beautiful dark blue to reddish violet, and MnS into dull gray to bright white.

Whitely recommends that 5 g. gelatine be soaked one hour in 20 c.c. water and 15 c.c. gelatine added. Heat till clear, add 0.05 g. tartar emetic in 1 c.c. H_2O, filter, and add 1 c.c. dilute H_2SO_4. Apply warm. Yellow ring forms around sulphides.

McCance[7] replaces tartar emetic by 0.1 g. $AgNO_3$, when a black stain indicates sulphide.

Comstock[8] uses boiling alkaline picrate of soda. MnS is blackened and roughened, while silicates and oxides are unaffected.

[2]Stead, *Iron and Steel*, vol. 9, p. 105.
[3]Law, *Journal*, Iron and Steel Inst., vol. 2, p. 94 (1907).
[4]Matweieff, *Revue de Metallurgie*, vol. 7, p. 447.
[5]Regent due to McCance. Action occurs in three seconds. Another recommended solution contains 8 c.c. HF, 42 c.c. water and 50 c.c. alcohol.
[6]Rohl, *Journal*, Iron and Steel Inst. Carnegie Memoir, vol. 4, p. 28 (1912).
[7]McCance, *Journal*, Iron and Steel Inst., pp. 1-239 (1918).
[8]Comstock, *Transactions*, A.I.M.E., vol. 56, p. 553 (1916).

Hardened Rosin and Resin Esters

A Study of the Special Treatment of Rosin for Use in Tung-Rosin Varnishes—Empirical Methods Now in Use Should Be Replaced by Better Technology and Chemical Control—Description of Experiments to Determine Optimum Conditions for the Esterification

By ALEXANDER MURRAY

WITHIN the last decade or so the art of varnish-making has been completely revolutionized by the extensive introduction of tung or chinawood oil varnishes. Previous to this time much rosin had been used for the adulteration of varnish gums, and, in the form of "gloss oil," as a cheap and deleterious addition to paints and enamels. Gloss oil is a solution of lime-hardened rosin in benzine.

It has been realized for some years that rosin has wonderful adaptability in combination with tung polymers for the production of varnishes of great and varied utility, having remarkable properties and fair durability. The outstanding characteristics of tung-rosin varnishes are extremely pale color, great rapidity of drying, high gloss, waterproof properties and very fair durability. Accordingly rosin has risen from the position of a despised adulterant to a necessary raw material of extensive applicability. Tremendous quantities of these varnishes are used today. Some are simply tung rosin and thinners; others contain proportions of linseed oil or other oils or resins.

Untreated rosin is not satisfactory for this purpose for many reasons. It is too soft, too acid and neither waterproof nor durable. Raw rosin feels sticky or tacky, even in the heat of the hand. Its softening point is about 70 deg. C. The acid number averages about 160. When exposed to moisture it turns milky white, probably due to penetration of moisture with the formation of an emulsion film on the surface. Rosin is a plastic, non-crystalline solid. It has sometimes been called a colloid, though probably on insufficient evidence.

The present paper deals with the special treatment of rosin, in relation to its use in tung-rosin varnishes. It will be seen that even in this one phase of varnish making there is a fascinating field for research. While there has not been an absence of chemists in the industry, they appear to have concentrated most of their efforts on the testing and analysis of varnishes and raw materials, rather than undertaking research with a view to developing a scientific rationale for the manufacture of their products. There is, of course, great opposition from the professional varnish makers, who in general seem to feel that their interests are best served by a policy of secrecy.

Untreated Rosin in Varnish

If rosin is dissolved in benzine and this solution then brushed out on some surface and permitted to dry, it will be found that when the thumb is pressed down firmly upon it the film will appear tacky. This tackiness persists when raw untreated rosin is used as a major ingredient in the preparation of a varnish. The latter might appear to dry satisfactorily, especially in cold weather, but in a warm room or on a hot summer day, if one were to be so unfortunate as sit in a chair that had been finished with it, he would be likely to experience the embarrassing fear that an essential section of his clothing was not coming with him when he started to arise.

The untreated rosin varnish may have a remarkably high gloss when applied, but it becomes dulled rather rapidly. This varnish also gives inferior service outdoors. Gardner has shown that it is entirely unsuitable for concrete and cement paints, because of its very high acid number.

Necessity for Treating the Rosin

It is apparently assumed by some that a combination occurs between the wood oil and rosin, with the resultant production of a new compound of indefinite composition. There is no real evidence, however, that any such reaction occurs, and, on the contrary, observation indicates that no combination occurs between the rosin and tung polymers other than physical interdispersion, and that the properties of the rosin are not changed in any absolute sense, but only modified or diluted by the presence of the tung oil. The heating to which the colophony is subjected in the cooking of the varnish is insufficient to change its characteristics to any marked extent, and such change, contrary to some opinions, tends actually to soften besides darkening it. In some recent experiments the writer found that after heating rosin for one hour at 300 deg. C. the softening point had been lowered 2 deg. C. and the acid number reduced to 149. Since it is well known that on distillation rosin breaks down into lighter distillates, rosin oil and tar, a lowering of melting point should be expected when it is heated to incipient distillation for any length of time. When the varnish is to be used in conjunction with pigments, there is an additional reason why the rosin acids must be neutralized, since the latter are adsorbed by basic pigments and in time combine with them chemically. (The author hopes to present some evidence for this statement in a future paper.)

Empirical Methods for Hardening Rosin

It is desirable, therefore, to treat rosin for the two fundamental purposes of increasing the melting point and neutralizing it; this can be done either as a part of the varnish-making process or as a separate operation. The expression "hardened rosin" is technically applied only to rosin which has been neutralized with lime. There is much difference of opinion among varnish makers as to the kind of lime to use, and the technique—such as temperature, stirring and method of adding lime. Ask half a dozen expert varnish makers the correct way to harden rosin, and you will get half a dozen different methods.

It was formerly generally supposed, and is today still

affirmed by many, that oyster-shell lime has no equal for this purpose. The investigator constantly uncovers dogmas that might cause in him a tendency to smile, but most fetishes have some foundation in fact, and this one is a good illustration. Oyster-shell lime is weaker in CaO content than a good grade of hydrated chemical lime, but is technically free from iron and magnesia, and of course its composition is reasonably constant. Many commercial limes contain appreciable amounts of iron, which is taken up by the rosin and discolors the product. As for magnesia, its effect is peculiar, due to the fact that solutions of magnesium rosinate have much higher viscosity than solutions of the calcium salt. Very small proportions have a noticeable thickening action, which is highly undesirable, since the tung polymers themselves have great viscosity. The magnesium salt is much less fusible than rosinate of lime, which presents an additional disadvantage if the MgO content is high. A suitable lime should not contain over 1 per cent of MgO, and should be technically free from iron.[1]

It will be readily appreciated from the foregoing that the empirical varnish maker, without chemical control, might be very badly impressed by a change from oyster-shell lime to one of unknown composition.

The details of neutralizing would appear to be of the simplest order, but here one is surprised to find frequently that the more complexity and mysticism one can add to the process the better will be the ultimate result. The following is a typical formula: "Melt 400 lb. of rosin in a copper kettle, raising the heat to 500 deg. F.; sift in 32 lb. of oyster-shell lime. Do not stir the mix. Raise the temperature to 550 deg. F. and hold there until the lime is taken up, then remove from fire."

Hot rosin darkens rapidly in contact with the air, and since pale color is ever desirable and since nothing is gained by high temperatures, it should be subjected to only the lowest practicable temperatures for the shortest possible time. This rule should be observed at all times when cooking rosin. It darkens more quickly than heated oils, and therefore it should be added to the batch of varnish at as late a point in the cooking as possible. When using 6 lb. of lime to 100 lb. of rosin, the latter may be heated to 400 deg. F., the lime then added (it need not be sifted) and thoroughly stirred in for about ten minutes, when the operation will have been completed.

Preparation and Uses of Pale Hardened Rosin

It is not possible to prepare pale hardened rosin with much less than 30 per cent of free rosin, because of the high melting point of the rosinate, and in order to get even this degree of neutralization it is necessary to cook the rosin with 9 lb. of lime per 100 lb. of rosin at a temperature of 435 to 440 deg. F. for one and one-half hours. In this case one would, of course, keep the kettle covered during the cook.

Rosin can be subjected to a great deal of cooking in covered aluminum kettles without darkening at all, and the rosin acids do not appear to attack the metal to any marked extent. If the hardening is being conducted as an integral part of a varnish cook, the next ingredient is added as soon as the lime is combined; and if being limed separately, the hardened rosin is ladled into shallow pans to cool, and then broken up and stored for future use. The advantage of liming large batches of rosin at a time is, of course, primarily the saving of labor and fuel, but it also facilitates uniformity, since it is possible for the laboratory to follow the neutralization closely, and make corrections when necessary. In cases in which the oils have to be cooked for an hour or longer it is advisable, from the point of view of the color of the product, to have the rosin already hardened and add it at a late stage of the cooking.

Hardened rosin varnishes are still unsuitable for use in concrete, plaster and cement coatings, since they contain considerable free rosin acids. They also caused serious thickening when used with zinc oxide and some white leads and lithopones before this reaction was better understood. Furthermore, hardened rosin is very brittle and imparts this property to a varnish to an extent proportional to the amount used.

Resin Esters and Their Preparation

The preparation of esters of the resin acids has received attention for some time, and glyceryl triresinate is being used extensively. By this method the rosin acids can be completely neutralized if desired.

There are on the market resin esters known as "ester gums," some of which are very pale in color and are said to have been vacuum-distilled. It has been found that some of these darken readily when cooked and that the resulting varnish is not lighter than that prepared from esters made in the varnish kettle in the manner described below.[2] The latter esters have the additional advantage of lower cost.

The reaction, of course, is well known. The amount of glycerine required by theory is about 10 per cent of the rosin, although the author has found as high as 20 per cent being used in practice. Gardner[3] used 15 lb. of glycerine to 100 lb. of rosin, but did not get a triglyceride, as will later be explained. Free glycerine is very undesirable in a varnish, as it reduces the resistance to moisture and causes rapid deterioration of the film, especially with exterior exposure. It is further necessary to use a minimum amount for economic reasons, glycerine being usually the most expensive ingredient in the formulas in which it is used.

Optimum Temperature

In the writer's experiments to determine the optimum conditions for esterification, temperature received first consideration. When glycerine is added to melted rosin at 150 deg. C., combination is seen to commence immediately, as evidenced by the formation of water in the mixture, which causes some foaming and apparent ebullition. The fused material is clear, but drops removed and cooled will show a milky appearance. The acid number is found to decrease rapidly, but one may cook at 150 to 250 deg. C. for hours and a large part of the rosin will still remain unneutralized, no matter how great an excess of glycerine is used. Now, if the temperature is raised to 290 deg. C., the boiling point of glycerine, the last portion will rapidly combine and an almost neutral ester will result.

It is necessary to keep the batch covered during

[1] See also H. A. Gardner, "Lime for the Varnish Industry," Circular 113, Educational Bureau, Paint and Varnish Manufacturers' Association, for a comparative discussion of the properties of many commercial limes.

[2] The author's work on esters, reported herewith, was completed before the publication of Gardner's paper on "Tunga-resin."

[3] See "Papers on Paint and Varnish," p. 234. See also p. 214 for patent literature.

esterification, in order to prevent excessive discoloration and loss of the glycerine, which is readily carried off by the water vapor. It is not advisable to use a condenser of course, as the steam must be permitted to escape.

The result is a glyceryl triresinate, which, if carefully prepared, will have an acid number of less than 5. This ester, however, has a somewhat lower melting point than the original rosin, as might be expected from our previous experience with other organic esters. Accordingly the ester is slightly more tacky than the rosin itself. It is the opinion of the author, although he has not yet had sufficient confirmation to state it as a fact, that after the ester has been combined with the tung polymers, its tackiness is not as pronounced as the stickiness of rosin and that the film has a softness that makes it more durable in certain uses, notably in furniture varnishes and exterior coatings. Such a varnish is very elastic and waterproof and practically neutral, and is of value in the preparation of paints for concrete, cement, and plaster surfaces.

The addition of 0.5 per cent of a cobalt drier has been recommended to overcome the tackiness of rosin ester, but this quantity would represent an excess of a powerful drier, to be avoided on general principles, and besides would cause serious darkening of the product. The melting point of rosin ester is raised in practice when desired by the addition of a small amount of lime or some hard resin, such as Congo copal.

Time of Esterification

After determining the optimum temperature the next factor to be ascertained was the time. In this connection it was found that, esterifying at 555 deg. F., the reaction passed through a peak about fifteen minutes after this temperature was reached. Working with 12 lb. of glycerine to 100 lb. of rosin, a resin ester with an acid number of 5 to 10 was obtained in that time, and if heating was continued there resulted a gradual increase in acidity, due apparently to decomposition of the ester after the excess of glycerine had been consumed. This is analagous to the action of the glyceryl esters of the higher fatty acids, such as those of linseed oil, which decompose under prolonged heating with the accumulation of increasing quantities of free fatty acid. The latter are more stable than the resinates. A sample of linseed oil will reach an acid number of about 20 after heating for, say, five hours at 575 deg. F.

It is necessary, then, for the varnish maker, with the aid of his control laboratory, to determine the peak of his esterification and stop cooking at that point. It is desirable not to use sufficient excess of glycerine to neutralize the rosin completely, but to use not more than 12 lb. of glycerine, and when the neutralization has proceeded to the maximum, stir in half a pound of lime and remove the kettle from the fire. The resulting ester will be practically neutral, and the small amount of lime contained will act beneficially as a hardening agent.

The complete procedure can be illustrated by the following example:

Melt 600 lb. of rosin in a copper or aluminum kettle, and when the temperature reaches 400 deg. F. slowly add 72 lb. of glycerine—it is not necessary to stir, as the liquid is strongly agitated by the escaping steam. Increase the temperature to 555 deg. F. and hold it there for about twenty minutes or the exact time that is found to give maximum esterification, which may vary slightly with different apparatus and materials. Then stir in 3 lb. of lime, remove the kettle from the fire, and ladle the ester into cooling pans.

Addition of Congo Copal

We have previously referred to the addition of Congo gum as a hardening and toughening agent. This is a hard fossil resin, melting with partial decomposition at a high temperature and having an acid number of about 133. The esterification of Congo copal presents considerable difficulty, as it will not melt at 555 deg. F., and glycerine cannot be used in unsealed kettles at higher temperatures.

The addition of 10 per cent of Congo to rosin ester was found to improve the latter greatly, adding considerable toughness and hardness. This addition can be accomplished by cooking 90 parts of rosin with 10 parts of Congo, keeping the kettle covered, at 600-610 deg. F. until the Congo is completely dissolved in the rosin. No rosin can be esterified unless it is in a liquid condition. When the Congo is entirely melted, the batch is cooled to 550 deg. and 12 parts of glycerine added. The temperature is then raised to 555 deg. F., and the remainder of the procedure is the same as with pure rosin.

Catalytic Polymerizing Action of Copper

Working along the same lines with increased quantities of Congo in a copper kettle, it is found that severe darkening takes place, accompanied by uncontrollable foaming, which increases with the amount of the hard gum used. When a proportion of two parts of Congo to one part of rosin was reached, the mass became very dark and solidified before the glycerine could be combined. This solidification occurred very rapidly at 555 deg. F. and strikingly resembled the polymerization of tung oil. After several unsuccessful attempts to control the reaction in copper the experiment was repeated in aluminum, with the result that foaming and darkening were negligible and the ester remained liquid until the end of the operation and could then be readily poured or ladled from the kettle. It is possible to make esters in aluminum with three parts Congo to one of rosin, using 10 lb. of glycerine per 100 lb. of resins. The resulting ester has a hardness approaching that of Kauri, an acid number of 7.5 or less, and lends itself to the preparation of varnishes which are paler in color than those which can be made from Kauri. As a result of these experiments it is obvious that copper acts as a polymerization catalyst on Congo copal.

In regard to the covering of the kettle while melting and cooking resins, it should be noted that unless the cook is very short, air should be excluded as much as possible to prevent darkening of the product. It is interesting here to contrast the well-known fact that linseed oil shows a maximum darkening if it is cooked in the total absence of air—e.g., in an inert atmosphere—and also darkens considerably if cooked in a covered kettle.

The writer regrets that lack of facilities and time has prevented his accumulating more exact scientific data on the reactions and properties of the materials discussed in this paper, but would suggest that here is a practically virgin field for research of real and immediate value.

Springfield, Mass.

An Improved Type of Filter Press

Comparison of Advantages and Limitations of Various Types of Filtering Apparatus and a Description of a Modified Form of the Plate and Frame Filter Which in Certain Features Appears to Present a Number of Important Improvements

BY CHARLES D. BURCHENAL
Consulting Engineer

THERE is no single type of filtering apparatus which can be used to the best advantage for all classes of filtration work. Although the plate and frame filter press is capable of performing a great many filtering operations, it requires hand labor and is intermittent, so that if conditions permit some other filter which will give continuous operation or a reduction of labor would have certain advantages. These economic advantages, however, should not be permitted to blind one to certain inherent faults in such a filter, and in each filtering problem all conditions should be studied and the proper apparatus determined by a process of elimination.

The following order of considerations is suggested:

First. When the material is of a free filtering nature, containing no heavy particles or any colloidal matter to plug up the pores of the filter cloth, it is obvious that some form of rotary vacuum filter should be used in order to take advantage of continuous operation and the elimination of labor in dumping.

Second. When high pressures are desirable and when the solid matter is not to be recovered in dry form, the rotary pressure filter may prove suitable, and although the operation is no longer continuous and the advantage of automatic discharge is lost, the labor of discharge is less than with plate and frame filter.

Third. When a solid cake is required, no more simple and effective apparatus has been devised than the plate and frame filter, which since its invention fifty years ago has increased in usage and is today the most widely used type of filter.

INHERENT ADVANTAGES OF THE PLATE AND FRAME FILTER

The inherent advantages which are responsible for its popularity are simplicity, ruggedness, cheapness and a compactness that gives the greatest possible filtering area for the size of the machine. Cloths are easily removed and replaced without any sewing or wastage. Cakes, being inclosed, cannot get away from the positive flow of wash water or drying air, which may be supplied at high pressures. There is practically no filtering operation which cannot be accomplished by the plate and frame machine, but it has the disadvantage of requiring hand labor to dump and dress its frames, and it is this that has inspired the design of every attempted substitute.

USE OF THE FILTER PRESS IN THE SUGAR FACTORY

One important use of the filter press has been in the treating of settlings from the raw juice of sugar factories. Here the hot filtrate and hot washings must be recovered with a minimum loss of heat and with as much speed as possible (to prevent inversion of the sucrose) and the cake must be recovered in dry form for use as fertilizer. Furthermore the material contains cane wax and colloidal matter, which necessitates the frequent removal and washing of the cloths in a laundering machine with hot water. It would appear, therefore, that any filter having its cloths sewed or fastened in place is seriously handicapped for this work.

A decantation system has recently been proposed for this use and installations have been made in a number of foreign countries. However, the element of time required and the possible failure to remove lighter suspended particles have caused the desirability of the scheme to be questioned by some sugar engineers, for these two points are of greatest concern to the sugar boiler—viz., the inversion loss of sucrose through delay in the dilute stage and the presence of impurities in the resulting massecuite, which prevents the recovery of the otherwise crystallizable sugar.

DESIGN OF AN IMPROVED FILTER

Realizing its importance, the writer has made a study of the plate and frame filter for the past few years and has developed a form which eliminates some of its disadvantages and at the same time simplifies the already comparatively simple machine. This improved type of filter press has been given the trade name Duplex, since it employs double inlets, double outlets, and a new method of supporting the cloth which gives (in the early stage of the cycle) practically double the usual filtration rate. Due to a special support for the cloths which allows the free passage of filtrate at all times, cakes may be formed of unusual thickness, thus reducing the labor, since the filter is dumped at less frequent intervals. A double system of washing is provided so that all cakes may be washed (in alternate directions if desired) by

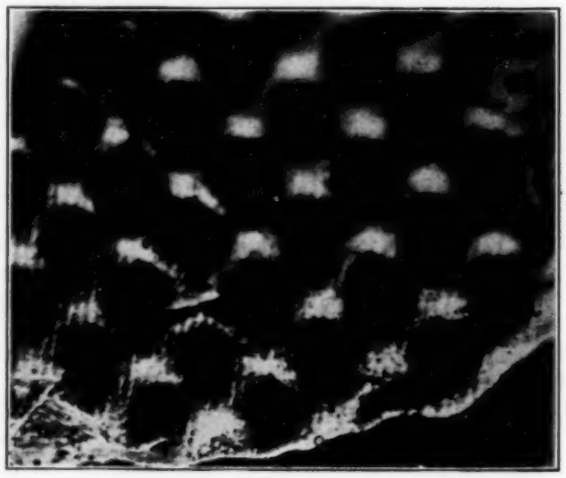


FIG. 1. SURFACE OF CAKE OBTAINED WITH PYRAMID SURFACE. PLATE SHOWING DEPTH OF INDENTATIONS

the manipulation of a single valve. It is not necessary to close drip-cocks on every alternate plate, as is usual in a washing type press, and all plates are exactly alike. Drip-cocks have been eliminated as well as the open drip gutter, yet turbid filtrate from any one cloth can be detected and shut off without stopping the flow from a perfect cloth on the opposite side of the *same plate*. The absence of drip-cocks simplifies the operation, and

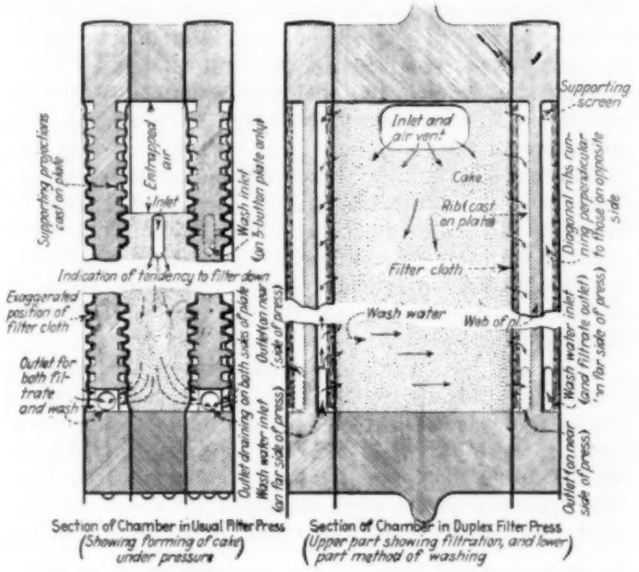

Supporting projections cast on plate
Entrapped air
Inlet
Wash inlet (on 5-button plate only)
Indication of tendency to filter down
Exaggerated position of filter cloth
Outlet for both filtrate and wash
Outlet draining on both sides of plate
Outlet on near (side of press)
Wash water inlet (on far side of press)
Section of Chamber in Usual Filter Press (Showing forming of cake under pressure
Inlet and air vent
Cake
Rib cast on plate
Filter cloth
Wash water
Web of plate
Supporting screen
Diagonal ribs running perpendicular to those on opposite side
Wash water inlet (and filtrate outlet) on far side of press
Outlet on near side of press
Section of Chamber in Duplex Filter Press (Upper part showing filtration, and lower part method of washing

FIG. 2. COMPARISON OF SECTIONS OF CHAMBERS IN USUAL TYPE OF FILTER PRESS AND IN DUPLEX TYPE

the substitution of a closed discharge for the open gutter saves the loss of heat, or loss by evaporation where volatile filtrates are handled. It also enables the operator to stand closer to the press, and in large units permits of mounting the press closer to the floor, giving easier handling and cleaner discharge of cake into floor hoppers.

Wire Screen Support for Cloths

In the usual form of filter press the cloths are supported on plate surfaces consisting of corrugations or a series of truncated pyramid projections cast on the plate, and as the cloths become coated and the pressure is consequently increased, they are pressed against the tops of these projections with such force that there may be no flow through the cloth at these points and the effective filtering area is decreased by the aggregate area of these points. As the pressure is further increased, the cloth is stretched and forced down between these points until it tends to lie against the web of the plate itself and actually does so where the pressure is sufficiently high, as can be seen by noting the depth of the corresponding corrugations on a hard cake, such as is shown in Fig. 1. Where the grooves are abnormally deep, actual contact with the web is probably never reached, but the condition is approximated. This condition not only further reduces the effective filtering area at the time when it is most needed but hampers both the run-off of the filtrate which does get through the cloth and the supply of wash water during the subsequent washing operation, since these constantly decreasing "valleys" behind the cloth are the only means of carrying away the filtrate to the drip-cocks and of admitting wash water to the cake surface. It is for this reason that with many materials the filtrate will cease to flow before a solid cake is formed and the thickness of the frames employed must be made smaller in order to obtain a solid cake.

In the Duplex press the cloths are supported on a special screen of wide mesh double crimp wire, which in turn is carried on widely spaced reinforcing ribs cast on the plate, so that ample space behind the cloth is provided for the fall of filtrate and for the easy access of wash water to the entire surface of the cake. No matter how much the cloth may stretch it cannot come in contact with anything except the surface of the wire, which is small and gives practically no reduction of the effective area.

Comparison of Rates of Filtration

So many variable factors enter into the rate of filtration that values obtained with one material are of little value for comparison with those derived with another in establishing the efficiency of a filter. The rate is constantly changing throughout any single operation and even the fairly definite value of average gallons per square-foot-hour for the cycle may vary on the succeeding run of the same material, in case it is of such a nature as gradually to clog the cloth pores. The graph shown in Fig. 3 is useful for showing comparative rates, only because both types of plates were supplied from the same pump, filtering simultaneously. For this test a single Duplex unit and a single pyramid surface unit were mounted in a press, supplied from a small laboratory triplex pump running at a constant speed with a relief valve set at 40 lb.

The material used was spent filter-cel mixed with bag fiber and other matter filtered from raw sugar washings in the leaf filters of a refinery. These solids settled rapidly and in passing over the large inlet openings to the

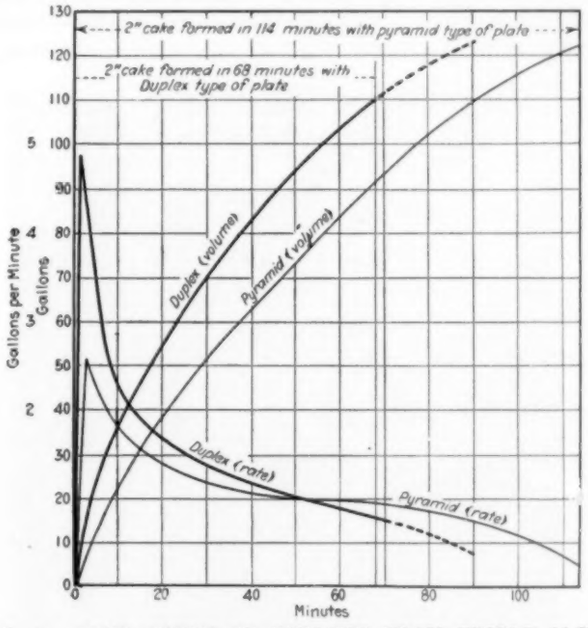


FIG. 3. COMPARISON OF RUN-OFF FROM SINGLE 36-IN. PLATES OF PYRAMID AND DUPLEX TYPES FILTERING SLUICING FROM SUGAR REFINERY LEAF FILTERS

Areas per plate, 14.6 sq.ft. Vol. per frame, 1.22 cu.ft.

frame nearest the pump settled in this frame enough to give the increase in density shown on the Duplex curve, where it will be noted that the solid cake was formed with the smaller volume of filtrate. These units being supplied from a constant rate pump, the filtration rate

of the Duplex plate could of course never exceed this small rate, so that the higher rate which is possible is not shown, as it would be if a monte-jus or centrifugal pump has been used.

The centrifugal pump is the ideal method for filter supply, as it gives a large volume of filtrate when the resistance is low and automatically increases the pressure as the flow diminishes. It is also free from pulsations which tend to compact the deposit on the cloths and it can never raise the pressure above its characteristic value to a dangerous point by failure of a relief valve. Each press should have its individual pump in order to get the most service from it. Where several presses are served from one pump, the empty press on being connected to the supply line will take most of the flow, as it offers the least resistance, and the other partly filled presses must stand idle until the new press has caught up with them in resistance. The resistance of the fresh press may be equalized by throttling it, but this of course cuts down the higher rate which is possible with the fresh press.

FIG. 4. FRAME SECTION SHOWING FOUR INLET PORTS AND ESCAPE OF AIR

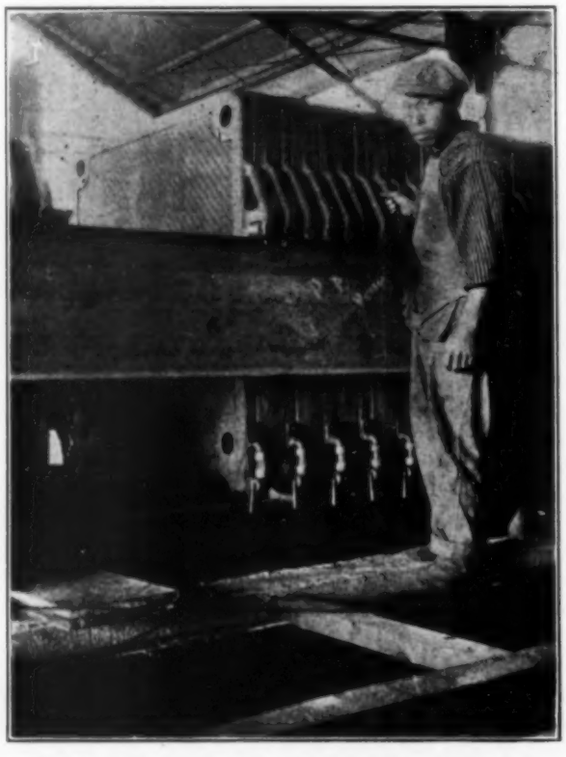


FIG. 5. VIEW OF PLATE SHOWING INCLOSED FILTRATE OUTLETS

Precautions Against Breakage of Plates

The breakage of plates is almost invariably caused by a difference of pressure on opposite sides, due to the plugging up of the inlet to the adjacent frame with some fibrous or foreign substance. This is a rather frequent occurrence in the usual type of press when used with material containing fiber, for the inlet to the frame consists of a single slot, which is necessarily narrow on account of the thin frame used.

The wide frames and the use of double feed channels in the Duplex press make it possible to provide four wide, flaring inlet openings to each frame, so that it is impossible accidentally to cut off the pressure in any one frame. Further insurance against breakage is given by the use of a stronger plate, which is obtained without increase in the metal by casting continuous reinforcing ribs diagonally across the plate, those on the back side of the plate running perpendicularly to those on the front side.

The use of two inlet channels in the upper corners has the further advantage of allowing the venting of air through one as it is displaced by the incoming liquid through the other when first filling the press (Fig. 4), thus avoiding the usual air-bound condition at the start. The full area of the cloth is thus used from the very start instead of being held back until the entrapped air has had time to bubble out of the drip-cocks along with the filtrate or seep through the cloth joint at the top of the press.

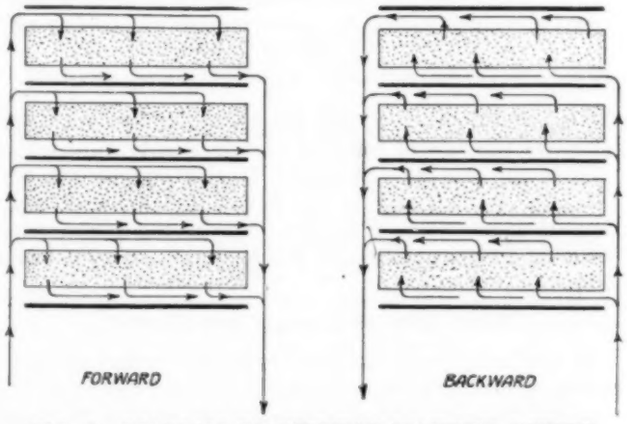


FIG. 6. DIAGRAM OF REVERSE WASHING SYSTEM

The use of two outlet channels at the bottom corners allows an ample area to carry away the filtrate when running at its maximum rate, as each plate, instead of being drained through the usual ½-in. cock, has two outlets, each equivalent to a ¾-in. cock.

Another novelty of design consists in the way these outlets are connected to the plate faces. The drainage from the front face of every plate is connected to the right-hand channel and to this one only, while the back face of every plate is connected to the left-hand channel only. These individual connections are made by bringing the filtrate out of the press at the edge of the plate through a short sight-glass and back again into the internal channel. In this way any defective cloth may be detected and its flow shut off by means of a stop-cock, while the flow from the cloth on the other side of the same plate may continue if desired.

These stop-cocks are merely a precaution in case of

defective cloths and are never opened or closed except in this emergency. In fact, where this risk is negligible, the stop-cocks and sight glasses may be dispensed with entirely without affecting the operation of the press.

In the usual press with drip-cocks, which is provided with a wash-water channel (opening into every other plate) the shutting off of turbid filtrate at any one cock will force the dirty liquid back into the washing channel, whence it will run out of the adjacent drip-cock. Consequently the whole set of drip-cocks is utterly valueless in this type of press as far as the stoppage of turbid filtrate is concerned. Some manufacturers have gone to the expense of providing a ball-check valve on each wash plate in order to prevent this.

Reversible Washing System

By admission to the lower left-hand eye, the wash water comes in contact with the entire front surface of each cake, whence it flows straight through the cake and

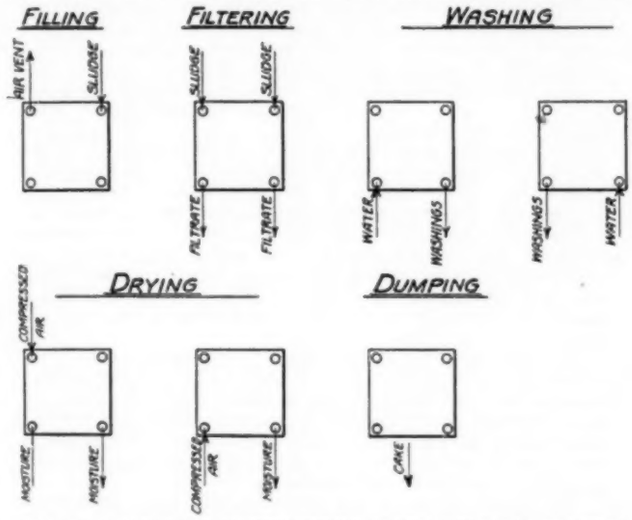


FIG. 7. CYCLE OF OPERATIONS WITH DUPLEX FILTER

out at its back surface into the space behind the cloth which drains into the lower right-hand eye. By admitting water to the left-hand eye and draining from the right, the cakes are all washed in the opposite direction —from back to front. Thus the flow may be reversed as often as desired by the handling of a single valve.

The inlets in the upper corners of the frames may also of course be used for washing, thus making it possible to apply water at all four corners in cases where this is of advantage.

In drying the cake compressed air may be admitted at the upper corners, driving the moisture out at the bottom, or it may be admitted at one of the lower eyes, blowing transversely through the cake and out the other lower eye.

The cycle of operations is shown in Fig. 7.

Commercial Installations

The original installation of a press of this type was made in a Hawaiian sugar factory and consisted of four hydraulically operated units, each forming forty cakes, 40 in. square of 4 in. in thickness—a capacity of 142 cu.ft. and having a filter area of 848 sq.ft. per unit. (See Fig. 8.)

These large frames are mounted on rollers and may be handled by two men, so that the labor cost is no more than in a small press and the labor per unit of solid is vastly decreased. Since the time of the original instal-

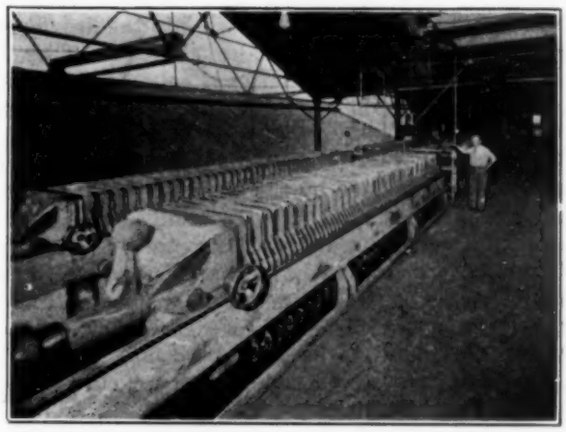


FIG. 8. ORIGINAL INSTALLATION OF DUPLEX FILTER

lation several improvements in the design of the press have been made. The filter is patented and is now being manufactured by T. Shriver & Co., of Harrison, N. J.

The latest installation (July, 1921) has been made by the American Sugar Refining Co. for use on the recovery of spent filter-cel from sluicing of leaf filters. These sluicings contain large amounts of jute fiber from sugar bags, which caused frequent breakage of plates, and it is the prevention of this which makes the machine of special value in this case.

With the perfect joint surfaces and the effective closing device of the modern filter press, the drip from the elements is negligible, but in this installation drip-sheets are provided as a precaution to prevent any drip into the floor hoppers, for the solid must be delivered as dry as possible to save the expense of evaporation in the subsequent retorting operation.

The drip-sheet used is turned up at its lower edge, forming its own gutter, which drains to a small sump at the end of the press. The sheet is split longitudinally

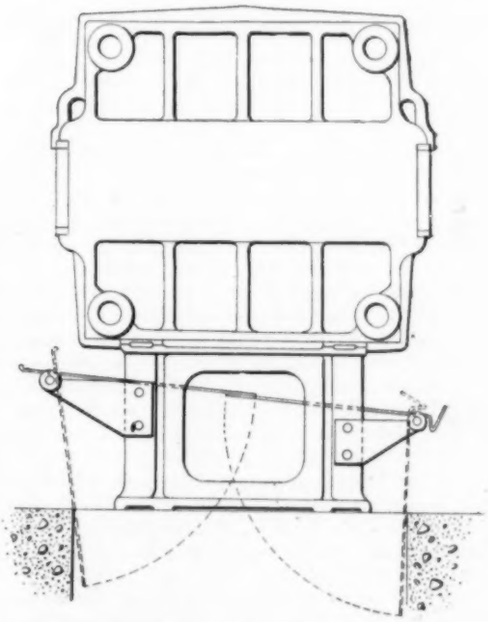


FIG. 9. DIAGRAM SHOWING ARRANGEMENT OF PIVOTED DRIP SHEETS

in two halves, each carried on a shaft running parallel to the axis of the press, turning in bearings on the press legs at either side. This gives a single overlapping joint down the middle when the sheets are in place, and when

not in use these halves swing down into the floor hopper, forming extensions to its sides above the floor line, assisting in the clean discharge of cake and preventing the necessity of the usual removal of the sheet in transverse sections.

It is believed that the use of some decolorizing carbons may be simplified by the application of the Duplex principle, for the liquid may be readily passed and repassed transversely in alternate directions through large volumes of carbon in the form of abnormally thick cakes. When exhausted, these may be washed and dumped, regenerated and reformed into cakes ready again for treating the liquid to be passed through them. This method is of course applicable only to vegetable carbons having a rapid decolorizing action.

One of the principal points in favor of the Duplex filter is that it has obtained its added efficiency by a simplification, rather than a complication, of the well-known plate and frame apparatus.

New York City.

Book Reviews

GASOLINE AND OTHER MOTOR FUELS. By *Carleton Ellis* and *Joseph V. Meigs*. 710 pp., 206 illustrations. New York: D. Van Nostrand, 1921. Price, $10.

The authors, Ellis and Meigs, have written a book for which there is undoubtedly a very great need. For several years past, processes for the manufacture of gasoline by various novel and usually startling methods have appeared in the newspapers, which have served no other purpose than to separate a few people from good money, and to arouse the idle curiosity of the commuter on his morning train. The authors are well known for their technical contributions and their volume on "Gasoline and Other Motor Fuels" contains admirable chapters calculated to explain what gasoline is, how it is obtained in the usual refinery practice, and how it is refined and tested. There is also an excellent discussion of the relative importance of benzene from by-product coke-ovens and other minor sources. There is also a very excellent discussion of the value of alcohol as a motor fuel and the possibilities in the distillation of oil shale, both of which subjects are bound to become of increasing importance. In fact, the only criticism which the reviewer can make of the present volume is the modesty of the authors in not being more critical of some of the subject matter, particularly the excerpts from the patent literature, which they include. In Engler's ponderous volumes on petroleum, it was evidently attempted to include all matter which found its expression in print and to present it to the reader impartially and without criticism and thus put it up to the reader to discern and select sense from nonsense. This seems to be one method of writing or rather compiling books on technical subjects. In justification of this method, it is sometimes said that an experienced investigator may get valuable ideas from the failures of others. However, it is probable that most persons referring to the work of Ellis and Meigs for information will be confused by a mass of descriptive matter taken largely from the fiction leaflets put through the United States Patent Office. Much material is included which will confuse the novice and needlessly waste the time of the better informed.

Another theory or method of writing on technical subjects is for the author to "Test all things and hold fast to that which is good," in other words, to exercise an editorial function, which he is supposed to be competent to do, of the subject whereof he writes and thus save the reader, who is presumably less well informed than the author, from wasting his time with the bizarre word play of patent lawyers and the often curious imaginings of those who make inventing an indoor sport. However, Ellis and Meigs are perhaps justified in refraining from the exercise of the editorial function since the art of producing gasoline from the higher boiling oils, which is the principal theme of their book, is still in an unsettled condition. Just a few days before the writing of this review, the Burton process, evidently the most successful of any of the processes which have had fair large scale trial, was reported in the press to have caused the death of seven men and the serious burning of about forty others in an explosion at Whiting, Ind. It is, therefore, well to keep in mind that the manufacture of gasoline from higher boiling hydrocarbons is a comparatively new art and that five or ten years from now the best process may be one which has not yet had fair large scale trial. However, it is doubtful if any one will be helped by rather lengthy descriptions of processes, such as the following, to which six full pages are devoted and the character of which may be judged from the following excerpts:

> It is asserted . . . . . that by heating oils which, like many crude petroleums and residua, consist largely of carbon compounds containing from ten to twenty or more carbons in the molecule, with a suitable control of the conditions, a depolymerization of comparatively simple and regulable type and without complex side reactions can be produced. Under proper conditions, it is said, the oil is broken down mainly into gaseous compounds, having two carbon atoms, without deposition of carbon or formation of tar.
>
> The oils best adapted are crude petroleums composed of oils . . . . . containing hydrocarbons with more than ten carbons. . . . .
>
> On exposing such high boiling hydrocarbons in vapor form to temperatures around 700 deg. C. (1,292 deg. F.) and within 50 to 75 deg. C. on either side of that point, a regularly gasifying depolymerization sets in with the production of low molecular gaseous hydrocarbons without any great amount of other synthetical or analytical side reactions as long as vapor of unchanged oil still remains in the sphere of action. Such vapor seems to have, it is stated, a shielding action on the products. . . .
>
> At 800 deg. C. (1,472 deg. F.) breaking down of ethylene, propylene, etc., is apt to begin. Another reason for the limit given is that with chambers of large section it is difficult to prevent stratification—a separation of oil vapors and gas. And a stratum of gas, free of oil vapors, is apt to suffer damage at temperatures which would otherwise be safe. . . . .
>
> The composition of the products will vary somewhat with that of the original oil and with the details of of operation. . . . .
>
> Admixing the gas with air or oxygen and passing over catalyzers such as platinum or palladium, various useful oxidized products may be obtained and condensed or absorbed, leaving the ethane. . . . .
>
> In recovering the olefins, instead of chilling the gas, it may be scrubbed with cold concentrated sulphuric acid which is claimed to have but little action upon the olefins proper. The acid solution upon dilution separates polymerized unsaturated aliphatic hydrocarbons. . . . .

BENJAMIN T. BROOKS.

* * *

FESTIGKEITSEIGENSCHAFTEN UND GEFUGEBILDER DER KONSTRUKTIONSMATERIALIEN—Von *Dr.-Ing. C. Bach* und *R. Baumann*, professoren an der Technischen Hochschule Stuttgart. Zweite, Stark Vermehrte Auflage. Berlin, Germany: Verlag von Julius Springer. Cloth; 8 x 10 in.; pp. 191; illustrated.

The rather unique German book noted above is an illustrated encyclopædia covering the strength of the metallic materials of construction. It presents graphs showing the relations between deformation and loading for a certain steel, for instance. Illustrations are printed alongside showing the typical test-bar, the surface of fracture and the normal microstructure. Many pictures are given of faulty structures and the nature of the breaks, both as seen by the eye and under the microscope. Carbon steels, plain and annealed, special alloy steels, cast iron and steel, malleable iron, brass, bronze, and the principal non-ferrous metals are covered in this manner in 950 illustrations. Apparently most of the material is original with the authors. Typographically the book is excellent, the micrographs being particularly well printed. It would be a good reference book for any control or testing laboratory, especially those working with ferrous metals.

E. E. THUM.

Synopsis of Recent Chemical & Metallurgical Literature

Sulphuric Acid During the War.—The story of the important rôle played by sulphuric acid in the World War is very clearly told in a paper by H. J. Bailey which was printed in the July 15, 1921, issue of the *Journal of the Society of Chemical Industry*. The stringent measures taken in Great Britain for conserving this acid and its principal raw materials are reviewed. Statistical data are presented showing the production and utilization of all acid produced in England during the period 1915-1918 and of the sources and consumption of pyrites, pyrites cinders, spent oxide and sulphur.

The chamber-acid plants of Great Britain reached their maximum output in March, 1917, when they were producing at the rate of 1,307,000 tons of 100 per cent sulphuric acid. In the following table the uses of the chamber acid during 1916, 1917, 1918 and five months of 1919 are summarized. The figures for the latter period show the transition toward normal peace-time practice.

SULPHURIC ACID FROM CHAMBER-PLANTS IN TERMS OF 100 PER CENT H_2SO_4

Summary of Uses

	1916, Tons	1917, Tons	1918, Tons	1919, (5 Mos.) Tons
Explosives	352,131	337,765	152,193	5,712
Dyes	17,736	9,688	9,143	5,207
Accumulators	2,696	3,145	3,075	822
Alum	24,854	24,406	26,184	11,233
Bichromates	8,433	5,710	5,316	1,863
Bleaching powder	70,413	50,302	50,694	10,471
Copper and copper pickling	3,360	2,702	1,339	380
Copper sulphate	21,705	27,032	30,424	9,540
Drugs and fine chemicals	3,098	4,479	4,225	1,308
General chemicals	9,203	9,217	9,624	3,734
Chemical warfare	39	1,122	1,678	93
Hydrochloric acid	71,872	53,510	52,227	26,105
Iron pickling	54,523	28,864	28,840	25,406
Metal trades, other than copper and iron	3,615	3,263	2,396	1,318
Mineral waters	2,421	490	391	1,884
Oil-refining	23,690	17,022	14,840	7,238
Paints and antimony colors	4,081	3,667	3,684	1,346
Sewage	442	307	723	1,613
Soap and glycerin	2,608	4,060	3,560	1,906
Sugar-refining	925	1,051	1,067	517
Sulphate of ammonia	253,340	230,145	231,092	116,144
Sulphates of magnesia and zinc	8,347	9,235	8,339	2,783
Sulphites and phosphates	10,717	11,009	12,504	5,015
Sundries	6,639	5,561	6,006	2,677
Superphosphates and compound manures	169,730	212,209	270,597	144,747
Tar	13,704	14,946	13,897	3,683
Textile industries	23,211	15,987	13,323	13,484
Totals	1,163,533	1,086,894	957,381	406,229

Practically all of the fuming acid or oleum was used in the manufacture of explosives, as may be noted from the following figures:

OLEUM (20 PER CENT FREE SO_3

	1916, Tons	1917, Tons	1918, Tons	1919, (5 Mos.), Tons
Production	183,000	367,000	288,000	7,500
Imports	5,500	1,500	.....	.....
Total	188,500	368,500	288,000	7,500
Consumption—				
For explosives	179,000	352,000	276,500	.....
For trade	6,500	11,000	18,000	*12,000
For export	.....	.....	1,000	.....
Total	188,500	363,000	295,500	12,000
Stocks on Dec. 31	11,000	16,500	9,000	4,500 (May 31)

* No separate data available.

The following data for the production and consumption hydrochloric acid are of interest:

HYDROCHLORIC ACID

	1916, Tons	1917, Tons	1918, Tons
Production 30 per cent HCl	272,633	288,991	263,580
Niter cake used	48,085	55,031	47,460
H_2SO_4 consumed (100 per cent)	111,120	107,431	101,707

CONSUMPTION OF HYDROCHLORIC ACID (30 PER CENT).

	1917, Tons	1918, Tons
Ammonium chloride	7,421	9,572
Aniline	814	1,083
Barium salts	2,446	2,444
Bleaching liquor, powder and chlorine	134,453	125,139
Carbonising	2,526	3,071
Drugs and fine chemicals	3,574	3,950
Dyeing and bleaching	18,148	14,577
Dyes	10,380	14,080
Extraction of metals such as gold, platinum, etc.	3,662	5,285
Foodstuffs and preservatives	1,854	1,743
General chemicals	2,598	1,867
Glue, size and gelatin	4,261	3,295
Leather	1,069	982
Metal-pickling	58,638	53,314
Paint, varnishes, colors, ink, etc.	3,279	2,135
Soap and glycerin	9,973	8,128
Metallic chlorides	20,103	12,145
Chemical warfare and explosives	459	1,836
Sundry purposes	3,257	2,063
Totals	288,915	266,709

The relation of sulphuric acid to the fertilizer industries is given detailed study and statistical tables are included which show production and consumption of superphosphates, mixed fertilizers, basic slag and ammonium sulphate.

Solar Cooker on Mount Wilson.—In a very interesting report of Smithsonian Institution's Explorations for 1920, vol. 72, No. 6, of Smithsonian Miscellaneous Collections, Publication 2619, Washington, 1921, there is a record of a solar cooker designed by Dr. Abbott at the Mt. Wilson Observatory. In this device Mrs. Abbott, who had charge of the experiment, was able to bake excellent bread, cook meat dishes, vegetables and prepare fruits and vegetables for preserving. In short, all cooking operations were easily performed except frying. It consists in a parabolic cylindrical mirror with a polished aluminum surface of about 100 sq.ft. which focuses the sun's rays upon a blackened tube filled with mineral oil which in turn communicates with an iron reservoir of oil in which are two baking ovens. A continuous circulation of the heated oil keeps the ovens hot. It is said that Mrs. Abbott was much envied for her cool kitchen and novel appliance by the ladies of the mountain.

The solar cooker was constructed on Dr. Abbott's plans, largely at the cost of grants for the American Academy of Arts and Science in Boston and the National Academy of Sciences. It has proved successful, although as yet it is somewhat of a luxury and is available for relatively cloudless regions rather than as a generally useful appliance. The device is very simple, the oil pipe being fixed above the mirror, which by a simple clockwork device may be made to follow the sun. The idea suggests itself that the apparatus might well be used as a pre-heater on bright days to the saving of considerable coal. It might also be used in tropical countries for drying fruits and for the preparation of copra. Again, it might be that a kitchen of this sort could be provided with a hearth for artificial heat to be used on cloudy days but with sun heat availed of on days that are bright.

Leather Industry in India.—A recent summary of conditions in the leather industry of India is contained in an article by Sir Henry Ledgard, which was published in the May, 1921, issue of the *Journal of Indian Industries and Labour*. According to this report "there exists in southern India and the Bombay Presidency a great number of tanneries, chiefly small but in the aggregate producing a great quantity of leather (mainly from cow hides and those not fully tanned), also a large number of tanned goat and sheep skins, most of the leather being exported to the United Kingdom. Little or no machinery is used in these tanneries at present. This trade is passing through a period of depression. In the Punjab there are seven or eight tanneries, in most cases designed to tan buffalo and cow hides and skins. At present they are producing much below their capacity, and chiefly buffalo leather; very little machinery is used and the leather is not fully tanned or set out, or rolled to render it solid and wear-resisting as good sole leather should be. This leather finds a market in most towns in northern India in the manufacture of the cheap bazar-made boots and shoes, also in repairing and resoling work. It could be made more valuable if machinery were applied to its preparation."

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Alloy for High-Temperature Uses.—The need in many metallurgical and chemical operations for an alloy which will withstand exposure to high temperatures without material oxidation or disintegration has prompted the development by Frank A. Fahrenwald, of Cleveland Heights, Ohio, of an alloy which is claimed to be sufficiently resistant for most practical purposes. The alloy consists substantially of 75 to 85 per cent of iron, 10 to 20 per cent of chromium, 2 to 6 per cent of silicon, 0.5 to 1 per cent of each of the metals manganese and titanium, and 0.2 to 2 per cent of carbon. (1,378,941; May 24, 1921.)

Alloys With Degasifying and Deoxidizing Properties.—Patents numbered 1,382,146 and 1,382,147 and issued to Calvin Vos, of New York, describe certain alloys, which because of special degasifying and deoxidizing properties are claimed to be of value in the manufacture of steel. These alloys consist of aluminum within the limits of from 90 to 95 per cent, magnesium within the limits of from 2 to 10 per cent, ferrosilicon within the limits of from 0.02 to 3 per cent and either uranium oxide or zirconium within the limits of from 0.01 to 6 per cent. Sodium fluoride is used as a flux. (June 21, 1921.)

Preparation of Glacial Acetic Acid.—Roland L. Andreau, assignor to E. I. du Pont de Nemours & Co. of Wilmington, Del., has described a process for preparing substantially anhydrous organic acids which is especially applicable to glacial acetic acid. In this process he is able to use sulphuric acid of 100 per cent strength without obtaining the usual decomposing and charring of the acetic acid formed. Briefly stated, the invention consists of carrying on the reaction between anhydrous sodium acetate and the sulphuric acid in the presence of a non-volatile and inert liquid such as paraffin. A double decomposition takes place very smoothly with the formation of substantially anhydrous acetic acid and of sodium sulphate, which remains in suspension in the oil in a finely divided state. There being no caking, the acetic acid is distilled over immediately. The distillate is of about 95 per cent strength or better. (1,381,782; June 14, 1921.)

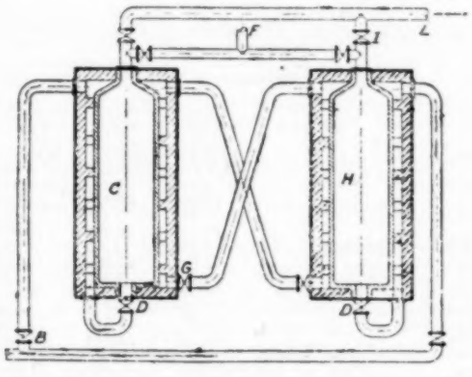
Process of Producing Phthaleins.—The usual condensation of phthalic anhydride with a phenol for the production of a phthalein—e.g., phenolphthalein—occurs only in the presence of some dehydrating agent such as concentrated sulphuric acid. Most of these condensing agents have the disadvantage of forming tarry byproducts which interfere with the refining of the final product besides giving a yield of only 30 to 60 per cent of the theoretical. A process which has recently been patented substitutes an anhydrous sulphonic acid or a mixture containing such an acid for the usual condensing agent. It is claimed that a yield equivalent to 90 per cent of the theoretical can be obtained in this manner. (1,381,503; Alfred L. Rispler, assignor to Monsanto Chemical Works of St. Louis, Mo.; June 14, 1921.)

A Basic Sodium Naphtholate.—As a substitute for solid sodium naptholate in the preparation of naphthol-carboxylic acids, L. F. Chebotaref, a Russian citizen residing in Wappinger Falls, New York, proposes a new substance, which he characterizes as a basic alkali naphtholate. In the case of the sodium salt this is prepared by fusing 15 parts of sodium naphthalene-beta-sulphonate with 11 parts of caustic soda for 2 hours at a temperature not higher than 350 deg. C. The sodium sulphite formed precipitates into the bottom layer; the upper layer when decanted and allowed to cool will congeal into a yellow crystalline solid, easily soluble in both water and alcohol. Its composition corresponds empirically to $C_{10}H_5O_2Na_2$ and in properties it compares with a substance represented by an addition product of 1 mol of sodium naphtholate and 1 mol of caustic soda. (1,381,280, assigned, by mesne assignments, to National Aniline & Chemical Co., Inc. June 14, 1921.)

British Patents

For complete specifications of any British patent apply to the Superintendent, British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treatment of Nitrous Gases.—In the absorption of dilute nitrous gases by means of solid absorption agents, and the decomposition of the resulting product to produce concentrated nitrous oxides and nitric acid, the combined process is conducted in retort-like, acid- and fire-proof vessels surrounded by gas-tight jackets capable of resisting comparatively high pressures. The hot gases before actually entering the retorts pass into the space between the jacket and the retort in order to heat the latter and thus enable either absorption or decomposition to take place. The absorbent may be such as is described in specification 137,071, consisting of a mixture of a dry base with one or more metallic oxides and the absorption is advantageously effected at 300-600 deg. C. In one form of the apparatus shown in the



figure, the furnace gases first pass to the vessel C containing material fully saturated with nitrous gases through the valve *B*, but before entering the inner retort traverse the interstices between the jacket and the retort. To facilitate the decomposition, which is preferably effected at a pressure below that of the absorption, a small portion of the furnace gases is led through the valve *D* actually into the retort and carries with it the concentrated nitrous gases and nitric acid to the exit *F*. The greater portion of the furnace gases leaves the vessel *C* by the valve *G* and enters the second vessel *H* containing fresh or denitrated material, after passing through the space between the retort and the jacket. The residual gases freed from nitrous gases escape through the valve *I* and pipe *L*. When the material in the vessel *H* becomes saturated, the circulation of gases is reversed—i.e., the furnace gases enter the vessel *H* and then pass on to *C*. The valve *D* may be shut off entirely, the necessary gases then entering the retort through holes in the retort walls. Alternatively the retort walls may be made porous. Instead of two vessels, a battery connected on the countercurrent principle or in any suitable manner may be employed. (Br. Pat. 163,026; not yet accepted. Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Christiania; June 29, 1921.)

Alloy for Permanent Magnets.—Steel alloys suitable for permanent magnets and other purposes are made by alloying with carbon steel, containing about 0.25 to 1.5 per cent of carbon, about 5 to 19 per cent of cobalt. Tungsten (or vanadium or molybdenum) or chromium, nickel and tungsten (or vanadium or molybdenum) may also be added, and also up to about 1 per cent of manganese. The tungsten may vary up to about 10 per cent and the nickel and chromium up to about 5 per cent each. Cast ingots of the alloys may be heated to about 1,000 deg. C., forged, hardened at about 850 or 900 deg. C., and magnetized. (Br. Pat. 164,039. Sir R. A. Hadfield, Westminster, July 20, 1921.)

Current Events
in the Chemical and Metallurgical Industries

Program, American Chemical Society Meeting

The final program for the sixty-second meeting of the American Chemical Society, New York, Sept. 6 to 10, is as follows:

TUESDAY, SEPT. 6

9 a.m.—Registration begins at the Chemists' Club, 52 East 41st St.
3 p.m.—Council meeting at the Chemists' Club.
6:30 p.m.—Dinner to the Council at the Chemists' Club.
9 p.m.—Adjourned meeting of Council, if necessary.

WEDNESDAY, SEPT. 7

9:30 a.m.—General meeting, Columbia University gymnasium:
Address of Welcome, John E. Teeple, chairman, New York Section.
Response, Edgar F. Smith, president, American Chemical Society.
"Chemistry and the State," Francis P. Garvan, president, Chemical Foundation.
"Mustard Gas," Sir William J. Pope.
"Organization of Industrial Research in Canada," Prof R. F. Ruttan.
12:30 p.m.—Society of Chemical Industry Luncheon to British and Canadian visitors.
2 p.m.—Divisional meetings at Columbia University.
4 p.m.—Reception and lawn party given by Columbia University on the university green, 120th St. and Amsterdam Ave.
8 p.m.—Smoker at Waldorf-Astoria.

THURSDAY, SEPT. 8

9:30 a.m.—Divisional meetings at Columbia University.
2 p.m.—Organ recital by Prof. Samuel A. Baldwin in the Great Hall of the College of the City of New York, 139th St. and Convent Ave., followed by
2:30 p.m.—International meeting:
"Chemistry and Civilization," Dr. Edgar F. Smith.
"Science and Civilization; the Rôle of Chemistry," by Prof. Charles Baskerville.
"Energy; Its Sources and Future Possibilities," by Dr. Arthur D. Little.
"The Engineer; Human and Superior Direction of Power," by Dr. Leo H. Baekeland.
"Chemistry and Life," by Sir William J. Pope.
"Theories and Their Development," by Dr. Willis R. Whitney.
"Research Applied to the World's Work," by Dr. C. E. K. Mees.
"Problem of Diffusion and Its Bearing on Civilization," by Prof. Ernst Cohen, of the University of Utrecht.
"Catalysis; The New Economic Factor," by Prof. Wilder D. Bancroft.
8 p.m.—Banquet at Waldorf-Astoria.

FRIDAY, SEPT. 9

9:30 a.m. and 2 p.m.—Divisional meetings at Columbia University.
8 p.m.—Public meeting, Columbia University gymnasium:
Presentation of Priestley portrait by C. A. Browne.
President's address, "Progress in Chemistry," Edgar F. Smith.

SATURDAY, SEPT. 10

Visits to plants of the following concerns have been arranged by the committee: National Biscuit Co., Ladew Co., Ziegel Eiseman Co., American Tobacco Co., Standard Oil Co. of New York, Standard Oil Co. of New Jersey, Manhattan Rubber Co., Passaic Print and Dye Works, Seaboard Byproduct Coke Co., Liebmann's Brewery.

DIVISIONAL MEETINGS

The following divisions and sections will meet on the days noted:
Division of Agricultural and Food Chemistry, Wednesday and Thursday, 16 papers to be presented.
Section of Sugar Chemistry, Wednesday, Thursday and Friday, 24 papers.
Division of Dye Chemistry, Thursday and Friday, 21 papers.
Division of Organic Chemistry, Wednesday, Thursday and Friday, 41 papers.
Division of Biological Chemistry, Wednesday, Thursday and Friday, 40 papers, including a symposium on vitamines.
Division of Physical and Inorganic Chemistry, Wednesday, Thursday and Friday, 48 papers.
Section of Leather Chemistry, Wednesday, Thursday and Friday, 24 papers.
Section of Cellulose Chemistry, Wednesday and Thursday, 11 papers.
Division of Rubber Chemistry, Wednesday, Thursday and Friday, 21 papers.
Section of Chemical Education, Wednesday, Thursday and Friday, 10 papers.
Division of Industrial and Engineering Chemistry, Wednesday, Thursday and Friday, 35 papers, including symposia on filtration and on the chemistry of gases and fuel.
Division of Fertilizer Chemistry, Wednesday and Thursday, 23 papers.
Section of Petroleum Chemistry, Wednesday, Thursday and Friday, 12 papers, including symposium on emulsification problems.
Division of Water, Sewage and Sanitation, Friday, 7 papers.
Division of Chemistry of Medicinal Products, Friday, 13 papers.

Steel Treaters' Convention

An imposing list of seventy-eight papers has been secured for presentation and discussion at the forthcoming convention of the American Society for Steel Treating, held in conjunction with an exhibit of metallurgical equipment at Indianapolis, Sept. 19 to 24, 1921.

Tool steels will be discussed in nine papers by Messrs. Brown, Calkins, d'Arcambal, Green, Marshall, Medwedeff, Nelson, Seidell and Townsend.

Various problems in metallographic research will occupy six papers, by Messrs. Dowdell, Gill and Bowman, Hoffman, Lau, White and Helrigel.

Fourteen papers on general practice in heat-treatment will be presented by Messrs. Blacet, Cowdrey, Cope, Janitzky, Keller, Langstroth, Haywood, Hoyt and Bierman, Lynch, Merton, Priestley, Ward, White and Gaun, while there will be nineteen papers descriptive of new heat-treating furnaces or pieces of miscellaneous equipment.

Management will be discussed in ten papers, by Messrs. Bellis, Blue, Bressler, Langenburg, Pierce, Smart, Woodside, Wood, Millard and Medwedeff.

Properties of carbon and alloy steels will occupy Messrs. French, Grossman, Johnson, McCormick, Styri, Vannick, Bird, Cox, Johnson, Holz and Wild.

Labor Disputes and Wage Reductions in British Chemical Plants

The following developments were reported recently by cable from London:

The Minister of Labor has intervened in the dispute between the chemical companies and their employees and it is expected that representatives of the employers and the men's union will again confer. The dispute affects 30,000 men.

Ninety per cent of the employees of the Brunner-Mond Co. have promised their employers that they will not walk out, even if a general chemical strike is called. (It will be recalled that the company threatened to close down its Winnington works unless sufficient men accepted the reduced wage and agreed to continue at work under the new wage scale.)

A ballot taken by the Scottish shale miners shows that the men agree to a reduction in wages amounting to 3s. 2d. per day.

Decision on Standard of Comparison in Minerals Separation vs. Butte & Superior Suit

Decision was rendered of Friday, Aug 12, by Judge George M. Bourquin, in the Montana U. S. District Court, on the motion of plaintiffs that the court determine a standard of comparison for the guidance of the master in the settlement to be made by the Butte & Superior Mining Co. to Minerals Separation, Ltd., et. al., for infringement upon patents.

Judge Bourquin's decision follows:

Plaintiffs' patent valid and defendant having infringed it (250 U. S., 336), the suit is in the final stage and has been referred to a master to take and state an account.

Therein plaintiffs move the court to determine a standard of comparison for the guidance of the master. The standard they contend for is processes known (1) at the date of patent, or (2) at the date infringement began.

Defendant resists specific and particular instructions to the master as calculated to embarrass the proceedings by vague determinations in respect to evidence before tendered, and maintains the proper standard is processes known at any time so far as subsequent infringement is concerned. The issue of relativity in time of standard and infringement has been exhaustively argued and briefed, and some time to be decided, better be decided now. There is no controlling decision in this circuit, the issue not having been expressly raised and determined in either Supreme Court or Circuit Court of Appeals. In several cases the Supreme Court's language is that the infringer accounts for the fruits of the advantage which he derived from the use of that invention, over what he would have had in using other means then open to the public and adequate to enable him to obtain an equally beneficial result.

The rule of comparison is settled law, and contemplates that the infringer had a choice of processes, chose that of the patent, and gained an advantage over what would have been his had he chosen otherwise. Obviously his choice is made from processes existing at the time of choice, that is, at the time infringement from day to day and as alternative presents itself. He is not limited in fact to the process of the patent and processes existing only at the date of the patent, and the principle of standards does not require nor sanction that he be so limited in theory. For the advantage he actually gains, and which as profits or savings he must render to the patentee, is only that of the invention over other processes he might have chosen in lieu of the invention and did not.

What the infringer thus gains is also what the patentee is presumed to thus lose, so far as accounting for profits is concerned, and equity is done when all such gains are taken from the infringer and given to the patentee; for thus the former loses nothing, he is not penalized, the latter is made whole, and he is not given gratuities nor rewarded beyond his present deserts, as otherwise would be the case. And it seems fairly clear that this is the import of the quoted language of the Supreme Court.

The event to which the court refers is the infringement, and the time to which it refers is "then" at that time, the time of the antecedent event.

In so far as the motion seeks a general and not a particular determination, it is granted. The standard of comparison that will govern the master is any standard (having in mind the distinction between processes and standard) that is duly made to appear, in respect to subsequent infringement.

Australian National Research Council Holds First Meeting

Sir Edgeworth David, first president of the Australian National Research Council, which opened its first session at Melbourne, Aug. 24, declared it was necessary to establish the basic chemical industries in Australia and to work for co-ordination generally, throughout the Commonwealth, of scientific effort.

New British Act Affects Chemical Imports

On Aug. 25 the Board of Trade announced that part 1 of the safeguarding of industries act, dealing with all synthetic and organic chemicals, would come into full operation on Oct. 1. All goods arriving in England on or after that date will be liable to duty regardless of the date when the goods were ordered.

American Ceramic Society at the Chemical Exposition

The American Ceramic Society will be represented at the Seventh National Exposition of Chemical Industries, booth 451. A larger booth than usual has been obtained this year in order that this may form a real headquarters for members at the exposition whether they be visitors or exhibitors. Small committee meetings may be held and appointments made to meet friends. Every member who plans to attend the exposition is asked to register at the booth and use it as his personal headquarters.

Friday, Sept. 16, will be Ceramic Day. In the afternoon a program along ceramic and chemical lines will be given by interesting speakers. In the evening motion picture films on the industry will be shown.

On Thursday and Saturday, Sept. 15 and 17, at 9:30 a.m., a conference will be held at the Hotel Commodore, including the board of trustees, officers of divisions and sections and members of the committees with ex-presidents. This conference has been called by President Pence so that the officers in each group in the organization can counsel together, formulate a general program of activities for the entire society, and discuss methods and policies. Efficiency and methods, definiteness and attractiveness of program, activity and persistency of directing officers and extent to which the individual members in each of the divisions and sections are kept informed and interested will be taken up.

Some of the divisions are growing in numbers and influence, while others are struggling for existence. Some of the standing committees have accomplished a great deal, while others do not know how to get started. Some of the local sections flourish, while others struggle along in indifference. Some of the divisions have co-operative working relations with other technical organizations and with industrial associations, while others have none.

The officers of each division, section and committee are urged to prepare for presentation at this meeting a statement of their activities, present and past, an exhibit of all printed notices and circular letters used at any time; and each division is asked to send at once to Ross C. Purdy, the new organizing secretary, a list of all industrial associations, together with names and addresses of officers, which, directly or indirectly, are or could be interested in the work of the American Ceramic Society. The society is also anxious to receive a list of addresses of all trade, industrial or technical journals and house organs, no matter how remote their interest might be, to which notices of the activities of the American Ceramic Society can be sent. The organizing secretary wants to learn of ways and means of assisting each group in the organization and is interested that everyone should be present at the conference to be opened on Sept. 15.

Annual Meeting of the Societe de Chimie Industrielle de France, October, 1921

The annual meeting of the Société de Chimie Industrielle de France will take place Oct. 9 to 12, 1921, in Paris. The following sections will be represented: Analytical Chemistry; Plant Machinery; Laboratory Apparatus; Gas and Coke Industries; Hydrocarbons, Petroleum; Wood Distribution; Refrigerating Industries; Water; Metallurgy and Electrometallurgy; Precious Metals; Heavy Chemicals; Fine Chemicals; Electrochemistry; Glass, Ceramics and Enameling; Rare Earths, Radio-active Bodies; Pharmaceutical Products; Photographic Products; Powder and Explosives; Essences, Natural and Synthetic Perfumes; Resins, Paints, Lacquers and Varnishes; Rubber and Substitutes; Fatty Materials, Soap, Candles, Glycerine, Cellulose, Paper; Plastic Materials, Artificial Textiles; Bleaching, Dyeing, Printing; Tanning; Fermentation; Sugar; Starch; Milk; Food Products; Agricultural Chemistry, Soils and Fertilizers.

An exposition of the chemical industry, Oct. 7 to 16, will feature this first annual meeting of the society.

Fertilizer Statistics

The National Fertilizer Association is co-operating with the Bureau of the Census in an effort to collect complete statistics on the production of acid phosphate and sulphuric acid.

Temporary Dye Control Extended

No real opposition was encountered in the Senate to the proposal to continue until after the recess the temporary control of imports of dyes. The subject came in for extended discussion, but there was no disposition on the part of any Senator to allow the measure to lapse entirely. Advantage was taken of the opportunity to denounce a permanent embargo. Senator Hitchcock attempted to establish that the War Trade Board, in handling the temporary embargo, had made it almost impossible for an American user to get imports of a dye in time to use it, even when it was not obtainable in the United States. Senator Smoot, in urging the passage of the extension of the control, among other things said:

> I am opposed to an embargo on dyestuffs or any other article of common use. I am for the extension of the temporary embargo, for the reason I wish to be fair with the dye manufacturers of the country. I believe we can give ample protection to the dye industry by the regular rates that may be inserted in the tariff bill.
>
> I am investigating conditions of every dye that is manufactured. I am taking the manufacturer's number of that dye. I am trying to find its cost abroad, at least the price for which it is sold when imported into this country and into foreign countries, both before the war and today. I am investigating the American value of those dyes, where they are made in this country. I cannot say today what rate of duty will be necessary. I do know, however, that in my investigation so far there must be two classes of dyes, if not three, and in those classes there will be a great difference in rates.

Senator Pomerene, of Ohio, stated to the Senate that imports of dyes in 1920 aggregated $5,000,000 in value. During that year dyes to the value of $29,000,000 were exported. This led Senator Smoot to say that 90 per cent of the exports consisted of a few articles, particularly synthetic indigo and sulphur black. He said that sulphur black has been made in this country for thirty years and that we can compete with nearly every country so far as that dye is concerned. We will not be able to compete with Germany in the manufacture of synthetic indigo, he declared, and just as soon as Germany gets back to quantity production of synthetic indigo that country will take all the markets outside the United States, he said.

In the course of the debate Senator McCumber, an influential member of the Finance Committee, made this significant remark: "Before we get through with the tariff bill, I think we shall have succeeded in getting a measure that will be sufficiently protective without an embargo."

While the general impression in Washington at the time of this writing is that the Senate committee will decline to restore the dye embargo to the tariff bill no decision has been reached and it is very evident that several members of the committee who are not particularly impressed with the embargo policy hesitate to accept responsibility for killing it.

Obituary

PETER COOPER HEWITT, electrical and mechanical inventor and engineer, died in the American Hospital in Paris, Aug. 25. He was born in New York on March 5, 1861, and was educated at the Stevens Institute of Technology and the Columbia University School of Mines. One of his earliest inventions was that of improved machinery in his grandfather's famous glue factory. His greatest success was achieved in the field of electricity—the Cooper Hewitt lamp, the Cooper Hewitt rectifier and other inventions bringing international fame. Because of his scientific attainments, Mr. Hewitt was made first vice-president of the United States Naval Consulting Board during the war and in that capacity he did much valuable patriotic service.

ROSS F. MACMICHAEL, of the United States Gypsum Co., Chicago, was drowned in Lake Michigan on July 10. Born in 1885, he was educated through private study. After occupying various minor positions he became field engineer for the American Smelters Securities Co. at Asarco, Durango, Mexico. Later he became associated with the Northern Clay Co., Auburn, Wash., carrying on technical problems in chemical engineering. Returning to the American Smelting & Refining Co. at Hayden, Ariz., as construction and experimental engineer, he invented the MacMichael chimney gas tester and the MacMichael viscosimeter. He had just come to Chicago to engage in the design of special machinery for the United States Gypsum Co. He was a member of the American Ceramic Society and the American Association of Engineers.

Dr. FRANK N. SMALLEY, chief chemist of the Southern Cotton Oil Co., died on Aug. 15 at the Homeopathic Hospital, Boston. Death was due to peritonitis, which set in following an operation. Dr. Smalley was born in Westborough, Mass., in 1874. He received his education in Massachusetts and was graduated from the Massachusetts Institute of Technology in 1898. A month later his services were secured by the Southern Cotton Oil Co., and he went to Savannah to enter its employ as one of its chemists. Some years ago he was given full charge as chief chemist for all of the laboratories of the company. Well known and highly esteemed in the cotton oil industry, his research work in his field caused his alma mater to confer on him the degree of doctor of philosophy. Dr. Smalley led an active life and had wide interests. He served as a non-commissioned officer in the United States Army shortly after the Spanish-American War and saw service in the Philippines. He was a member of the Society of Chemical Industry, the American Oil Chemists Society, the American Chemical Society and the American Institute of Chemical Engineers.

GEORGE W. THOMAS, president of R. Thomas & Sons Co., manufacturer of electric porcelain, died recently at his home at East Liverpool, Ohio, at the age of sixty-nine. He was the pioneer producer of high-voltage porcelain in the United States.

Personal

Dr. HOWARD ADLER has recently been made assistant professor of the department of chemistry of the University of Chicago and will also succeed Gerald L. Wendt as managing editor of the *Chemical Bulletin*, organ of the Western Sections of the American Chemical Society.

HOWARD W. AMBRUSTER, formerly general manager of Hemingway & Co., of Bound Brook, N. J., announces that he has opened his own office at 261 Broadway, New York City, for the purchase or sale of chemicals or colors.

R. R. DANIELSON, U. S. Bureau of Standards, Washington, D. C., is making an extended business visit in Chicago.

BURTON DUNGLINSON, formerly with the American Chemical & Sugar Machinery Co., is going to London to represent the Republic Flow Meters Co. of Chicago in the European field.

HERBERT A. HAUPTLI, superintendent of the Sears-Roebuck wall paper and dye plant, Chicago, Ill., is leaving for an extended trip to Europe to investigate methods of manufacture of wall paper, inks and dyestuffs.

J. T. SLEEPER, formerly manager of Ricketts & Co., Inc., and later research analyst for the Testing Laboratories of New York, has resigned from the latter position.

GEORGE OTIS SMITH, director of the United States Geological Survey, returned to Washington last week from London. The primary object of his visit to England was to serve as a member of the organization committee of the International Geological Congress, the next meeting of which is being arranged for August, 1922, at Brussels.

CLYDE E. WILLIAMS has been appointed superintendent of the U. S. Bureau of Mines Experiment Station at Seattle, Wash.

Current Market Reports

Chemical and Allied Industrial Markets

NEW YORK, Sept. 5, 1921.

Very encouraging reports were noted from the heavy chemical trade during the past week. Business seems to be showing a decided improvement and efforts to make this condition permanent are being made throughout the trade. Miscellaneous inquiries for small lots have increased and some sellers have placed considerable business. The volume of business is averaging better than it did a month ago, which is quite a favorable feature to record during the hot vacation period. Importing continues freely and importers find no difficulty in bringing in stocks of most materials at prices ruinous to domestic makers. The final settlement of the tariff question is expected to counterbalance this feature in a large way. Prices in general are fairly steady and are losing their recent softness. In many cases imported materials figure largely, but for the moment importers are holding their prices steady. Paper factories and textile mills have bought freely in certain commodities and inquiries from tanneries and dyers are on the increase. Shoe factories and enamelers are buying with a much better spirit and in larger quantities.

EXPORT SITUATION DISCOURAGING

The most discouraging feature at present is our export trade. Aside from the credit situation, foreign interests are underselling American producers in South America and other countries. Germany seems fully determined to win back her former commercial supremacy, regardless of what it costs. It seems problematical how far Germany can go on this price question, but it is the cause of no little concern to American interests which are not in a position to meet the keenest kind of competition. There were a few who expected a sharp decline in caustic soda. The resisting power and the gradual recovery of prices, however, speaks well for the underlying fundamental position of this chemical. Soda ash has also shown renewed strength and efforts to force the price down have not met with much success. It may be stated in general that the peak of the depression is passing and indications point to a steady improvement.

Advices from steel quarters indicate positive betterment. The decrease in the number of idle freight cars during July in spite of the fact that the greater part of the perishable freight had been moved before the end of the period has amounted to nearly one-third of their number. This fact alone has given a feeling of optimism to both consumer and manufacturers which will go a long way toward bringing better business, and its effects are already seen in the present improvement.

CHEMICALS

Buyers are calling for small lots of *bichromate of potash* and sales are reported at 11½c. per lb. There has been no apparent pressure in the market, but supplies seem sufficient to meet the current extent of inquiries. *Ammonium sulphate* has shown a noteworthy increase among the export and also domestic trade. Business has been very active and prices are named at $2.40@$2.50 per 100 lb. in double bags for steamer New York. Out-of-town soapmakers have taken large quantities of *caustic potash* at lately prevailing prices and reports are heard that the situation is becoming tighter abroad. While some dealers quote 4¼c. per lb. for imported 88-92 per cent, other large jobbers are asking above this figure and state that sales have gone through at 4½c. per lb. Producers of *acetate of soda* are asking 4¼c. per lb. for this chemical, but would undoubtedly accept 4c. on a firm offer, as recent sales have gone through at this figure. The movement is slow and devoid of particular feature. Trading in small lots of *bichromate of soda* is the best that can be reported at present. Transactions up to 5 casks are going through at 7¾c. per lb., with this figure named by most dealers. Offerings on spot are moderate and the tone is steady. Miscellaneous *caustic soda* inquiries are reaching the market in better volume. It is true that business is only moderately active, but the increased interest displayed seems to forecast expansion in trade in the very near future. It is difficult to place any European business on account of the strong competition existing. There are reports that some foreign producers have advanced their prices. Some South American business is going through and conditions at some points have improved materially. Spot sales are reported by dealers at $3.85@$3.90 per 100 lb. for standard brands. A few odd lots might be purchased at $3.80. No change from the former selling price of 7½c. per lb. can be reported for *chlorate of soda*. Business is confined to prompt shipments and the volume for domestic use is quite satisfactory. Small lots of *nitrite of soda* have sold at prices ranging from 7@7½c. per lb. on spot, depending upon size of order. It is possible that a slight concession might be granted on a round quantity, although holders of these lots seem to be somewhat tighter in their ideas. Spot prices for *prussiate of soda* are holding steady for the imported and it is doubtful if better than 12c. per lb. could be done in the open market at present. Dealers quote 12@12½c. and report a fair consuming demand for small quantities. The withdrawal of one of the largest low-priced sellers of *bleaching powder* on account of the disposal of output has put the market on a higher trading level. Producers are quoting 2½c. per lb. for large drums at the works and it is doubtful if second hands could shade this figure on any sizeable quantities. Paper mills have placed orders for considerable quantities during the past few weeks. Small drums are quoted at 2½c. per lb. lot works. Spot prime material in large drums is quoted at $2.85 per 100 lb., ex-store.

Importers of *oxalic acid* report sales at 16c. per lb. Brokers claim to be able to shade this price to 15½c. on odd lots, but dealers quote all the way up to 18c. for the domestic variety. Sales at the works are reported at 16c. per lb. Small-lot trading continues to feature the market. Sales of *zinc carbonate* are reported at 16c. per lb. by producers. On round lots a slight concession might be allowed. The present inquiry seems to be confined practically to small lots. Spot *zinc sulphate* is quoted at 3c. per lb., with occasional sales at $2.90 per 100 lb. The latter figure is considered an inside price for large-quantity orders. Moderate inquiries are reported from the paint and textile industries. Sales of imported crystal *tartaric acid* have been made at 26¾@27½c. per lb., the prevailing quotation at the close being 27@28c. per lb., according to quantity and seller.

COAL-TAR PRODUCTS

There have been quite a number of orders in the market for quantity lots of intermediates during the past week and in some directions this is taken as an indication of decided improvement. There are some who believe, however, that the recent orders are coming from those who have depleted their stocks which they took on some months ago and that they will not be in the market again for several months to come. In any case the outlook is considerably better, as indications point to improved consuming demand. The uncertainty of the tariff remains a ruling cause for slowness in the market, aside from the long-continued persistency of consumers in staying out of the market. Plants generally are barely moving and many are completely shut down. No large sales of crude material were made during the past week. Intermediates are moving slowly and manufactures are holding their quotations fairly firm, except where sharp competition is noted, as in the cases of *beta naphthol* and *aniline oil*. Resale stocks are greatly reduced on most items. There are only a scant few where prices are declining on account of accumulated resale material on hand. Producers of *benzene* quote 27@33c. per gal., but cannot supply any spot material. In order to take care of the c.p. demand it has become necessary for first hands to notify fuel oil consumers

that they can expect a curtailment of supplies on all new contracts. The greater number of coke ovens are shut down with no signs of any improvement at present. The market on *naphthalene* continues very quiet, with the demand at a virtual standstill. Refiners' prices remain unchanged at 8½@9½c. per lb. for flake, but, resellers are willing to sell even below their quoted figure of 6¾c. per lb. for quantity business. Resale Government *phenol* is to be had at 9@11c. per lb., according to packing and quantity. Government surplus stocks are still offered at 12@15c. per lb. Refiners of natural phenol are quoting 15@16c. per lb. for their product.

Business has been going on in routine proportions with the pharmaceutical trade. Resale lots of *beta naphthol* are to be had in good quantity at 32c. per lb. and reports are heard that makers are willing to do 34c., although they still deny it. Competition is keen and prices have been slightly shaded on round lots. The demand is somewhat slow. Makers of *aniline oil* have brought their prices well into line and are now quoting 20c. per lb., although some are still shading higher prices to this level. Resale lots are to be had in good quantity as low as 18c. per lb. Little interest is being displayed by consumers. Producers of *alpha naphthylamine* are quoting lower prices at 35c@37c. per lb. There is very little alpha offered by resellers in the spot market, as makers have retained control of stocks. Manufacturers of *dimethylaniline* are quoting 45@50c. per lb. according to brand and are pretty well in line within this range. Reports are current that sales have been made by producers as low as 42c. per lb., and while this seems possible no maker is willing to admit it. Makers' prices for *paranitraniline* rule at 79@82c. per lb., with resale material below this level in very light supply. The demand is rather slow. Producers of *paratoluidine* have brought their prices into better alignment and are now quoting $1.25@$1.28 per lb. Demand for small lots only has been noted.

Waxes

There was a moderate inquiry for crude *beeswax*, but the situation underwent no important change. Crude African held around 15@16c. per lb., according to quantity and seller, with the Brazilian at 22@25c. per lb. Pure white closed nominally at 36@42c. per lb. While offerings of *candelilla wax* were not pressing on the market, lack of demand caused prices to hold on the recently reduced basis of 25@26c. per lb. Interest in *carnauba wax* centered in the lower grades, although domestic consumers refused to anticipate their wants and business reported was only of a hand-to-mouth nature, confined almost entirely to small lots. No. 2 North Country held at 25c. per lb. with the No. 3 North Country at 15c. No. 3 chalky settled nominally at 15½c. per lb. Spot offerings of *Japan wax* were firmly held and at the close the market ranged from 19½@20½c. per lb., depending on seller and quantity. Strength at primary centers was the supporting feature. The market for *paraffine* was unsettled, with liberal offerings by large producing interests. The export demand has shown only a slight improvement and competition for pending business has been very keen with the result that price shading continues. Crude scale of 122@124 deg. melting point was available in carlots for immediate shipment at 1¾c. per lb.

The St. Louis Market

ST. LOUIS, Sept. 2, 1921.

In spite of the fact that the month of August has always been looked upon as a dull period for the chemical market, there have been many favorable reports coming in from manufacturers stating that business has increased to a great extent over the past months, and all are very optimistic as to what the future holds. It is the general opinion that there is a tendency for prices to harden, as the majority of the items, especially the major ones, have reached the level where they are consistent with manufacturing cost. The above facts not only cover the drugs, pharmaceuticals and fine chemical lines, but also affect the heavy chemicals, where the demand has increased steadily and has strengthened the market considerably. Not only have declines been halted but in several instances an upward change has been recorded. It is still true that buyers are very conservative in procuring their supplies and orders are not of large volume, but they are more numerous and frequent and in most instances are placed for immediate shipment. On some of the commodities the foreign material continues to be a disturbing element to the manufacturers. However, they are gradually becoming extinct.

Alkalis

Caustic soda demand is good and manufacturers' schedules strictly adhered to. Price has advanced to $4.25 per 100 lb. carload flat 76 deg. solid f.o.b. point of production. Further increases are not unexpected. *Soda ash* demand is fair with prices remaining the same—that is, $2.60@$2.75 per 100 lb. in less than carload lots. *Bicarbonate of soda* demand is poor, with the price $2 per 100 lb. for barrels or $1.75 per 100 lb. for bags, carlots f.o.b. producers works.

Chemicals, Drugs and Pharmaceuticals

Acetanilid is very dull. We are now at the threshold of the preserving and canning season and a good volume of business should be transacted on *benzoate of soda* and *acid benzoic*, and furthermore this should be the opportune time to procure requirements, as the prices on these commodities have undoubtedly reached bottom, and with an increased demand will have a tendency to advance. There is nothing more than routine business on *ammonia water*, 26 deg., with prices firm. *Bismuth salts*, particularly subnitrate, is moving very lively. *Bromides* are weak. *Caffeine* has shown a very substantial increase the past thirty days. The heavy demand for *carbon bisulphide* which was evident the past several weeks still continues. However, it is not expected that this condition will prevail much longer, as the demand from agricultural sources will cease the next few weeks. *Chloroform* and *ether* are two commodities which should be classified as stable articles, as they have a regular source of outlet. Manufacturers have reduced their price of *codeine* and its salts. There is nothing startling to report on *cream of tartar* or *acid tartaric*. *Creosote* and *guaiacol* should shortly show an increase, as we are about to enter the season of the year when these articles will be in demand and liberal stocks should be carried. *Epsom salts* is being quoted in carlots at $2.10 per 100 lb., f.o.b. factory, and less carlots at $2.60 per 100 lb., f.o.b. St. Louis. *Glycerine* declined one-half cent and is now quoted at 14c. in drums, spot or contract. This is an exceptionally low price and the manufacturers are not pushing contracts at this figure. *Mercurials* are firm with steady flow of orders. *Morphine* and its salts have been reduced. *Saccharine* has taken a sudden spurt with many inquiries received and in most instances business resulting. *Salicylates* continue to move in a fair way, and an increased demand is expected very shortly, as the season for the salicylates is now approaching. Several weeks ago it was reported that there was a brisk demand for *silver nitrate* and this condition still prevails. *Sodium hyposulphite* continues in routine way. *Sulphur* is in good demand, with price at $2.10 per 100 lb. for commercial in bags. The price of *zinc oxides* remains the same, with fairly good demand for the lead-free from the rubber trade. *Zinc sulphate* is ruling at 3½c. per lb. f.o.b. St. Louis.

Acids and Vegetable Oils

Producers of commercial mineral acids are very much pleased with the present free movement of acids, especially the *sulphuric* grade, which is moving in very large volume. Producers attribute the increase to the fact that many of the industrial plants which have been shut down for some months are beginning to operate. *Acid carbolic* is very quiet. The demand for *citric acid* has been very disappointing and very little improvement can be expected at this time, as the soft drink season is about to close. The demand for *acid pyrogallic* shows no inclination to drop off and the inquiries and demand continue to increase. *Acid tannic* is moving in fair way.

The *castor oil* movement has really been very heavy the past month and price of 11½c. per lb. for returnable drums is very firm. *Linseed oil* has held firm at 78c. per gal.

basis raw in barrels ex-warehouse. The majority of the buyers are taking spot oil as they need it. *Turpentine* continues to advance and it holds strong at 65c. per gal. in barrels ex-warehouse.

Paint Materials

Lithopone and *barytes* are unchanged in price and the demand is still much under routine, the expected activity in the paint industry having as yet failed to materialize.

The Iron and Steel Market

PITTSBURGH, Sept. 2, 1921.

The volume of demand for steel products, taken as a whole, has continued to increase in the past fortnight, albeit the increases have been relatively small and not altogether steady. Sheets, bars and tubular goods show improvement most distinctly. Shapes, plates and rails stand at the foot of the list. Tin plate and wire products show demand that is governed by the season rather than by general business conditions. All steel mills show improvement in bookings, comparing July and August.

As improvement in demand has been most pronounced in the lighter steel products, naturally no large increase in steel production is shown. The rate of steel ingot production this week may be estimated as nearer 30 per cent than 25 per cent, and it is possible a full presentation would show a rate above 30 per cent. This compares with an average in July of about 21 per cent and a rate probably between 18 and 19 per cent at the middle of July, when the record low point was reached. Production of finished steel has increased slightly more than production of ingots, as here and there stocks of semi-finished steel or ingots are being drawn upon.

As for weeks past, the prominent fact in an analysis of the purchases of steel is that the buying is widespread in character, both geographically and by trades. All sections of the country are represented more or less in the improvement, but the Southern States show the best gain in proportion to the volume of business two or three months ago.

Prices Much Steadier

A survey of the course of prices since the first of the year shows how much steadier the steel market has become in the past thirty days. The end of last year brought an equalization in prices between the independents, which had largely advanced their prices, and the Steel Corporation, which held to the Industrial Board schedule of March 21, 1919. January saw a continuance of the equalized prices, while February witnessed an inception of price cutting by independents. A weighted average of the prominent finished steel products shows that from Feb. 1 to Aug. 1 there was a decline of fully $15 per net ton, February and July each showing declines of more than $5 a ton, while in August the weighted average dropped only 80c. a ton. It is barely possible that no further declines will be recorded, taking a broad view of the price situation.

Pig Iron and Coke

Pig iron has been firming up in several districts in the past fortnight, and definite advances are recorded in the Buffalo, Chicago and valley markets. The trend in these cases is away from a market price that was below the cost of replacing the stock iron sold. On a general average, the freight assembly cost of ore, coke and limestone necessary to make a ton of pig iron is about $10, against about $5 before the war, and expectations are that the rates will be reduced by about 20 per cent. The freight rate reductions, however, have not occurred, and no one knows just when they will occur, while in some districts the stocks have been fairly well reduced, and here and there it is necessary for a furnace to resume operations. Naturally the furnace requires the buyer to pay its cost at least, when it has the recourse of not making iron. Liquidation of stocks was another matter.

The local market is quotable at $20 for bessemer, $19 for basic and $20 for foundry iron f.o.b. valley furnaces, these quotations representing no change in bessemer and advances of $1 on basic and 50c. on foundry. The common asking price on basic, however, is now $20.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride	lb.	.....	$0.40 – $0.45
Acetone	lb.	$0.12½ – $0.12¾	.13 – .13½
Acid, acetic, 28 per cent	100 lbs.	2.50 – 2.75	3.00 – 3.25
Acetic, 56 per cent	100 lbs.	5.00 – 5.25	5.50 – 6.00
Acetic, glacial, 99½ per cent, carboys, 100 lbs.		10.00 – 10.25	10.50 – 10.75
Boric, crystals	lb.	.12½ – .13	.13½ – .14
Boric, powder	lb.	.13 – .13½	.14 – .14½
Citric	lb.	.....	.45 – .47
Hydrochloric	100 lb.	1.25 – 1.50	1.60 – 1.75
Hydrofluoric, 52 per cent	lb.	.11½ – .11¾	.12 – .12½
Lactic, 44 per cent tech	lb.	.10 – .11	.11½ – .12
Lactic, 22 per cent tech	lb.	.04½ – .05½	.06 – .07
Molybdic, C. P.	lb.	4.00 – 4.50	4.50 – 5.00
Muriatic, 20 deg. (see hydrochloric)		.....	.....
Nitric, 40 deg	lb.	.06½ – .06¾	.07 – .07½
Nitric, 42 deg	lb.	.07 – .07½	.07½ – .07¾
Oxalic, crystals	lb.	.16 – .16½	.17 – .18
Phosphoric, 50 per cent solution	lb.	.13 – .13½	.14 – .18
Picric	lb.	.20 – .25	.27 – .35
Pyrogallic, resublimed	lb.	.....	1.75 – 1.90
Sulphuric, 60 deg., tank cars	ton	.....	11.00 – 13.00
Sulphuric, 60 deg., drums	ton	.....	13.00 – 15.00
Sulphuric, 66 deg., tank cars	ton	18.00 – 20.00	.....
Sulphuric, 66 deg., drums	ton	21.00 – 22.00	22.50 – 23.00
Sulphuric, 66 deg., carboys	ton	.....	.....
Sulphuric, fuming, 20 per cent (oleum) tank cars	ton	21.00 – 22.00	.....
Sulphuric, fuming, 20 per cent (oleum) drums	ton	23.00 – 23.50	24.00 – 24.50
Sulphuric, fuming, 20 per cent (oleum) carboys	ton	31.00 – 32.00	33.00 – 34.00
Tannic, U. S. P.	lb.	.....	.75 – .85
Tannic (tech.)	lb.	.45 – .48	.50 – .55
Tartaric, crystals	lb.	.....	.27 – .28
Tungstic, per lb. of WO	lb.	.....	1.30 – 1.40
Alcohol, Ethyl	gal.	.....	4.80 – 4.90
Alcohol, Methyl (see methanol)		.....	.....
Alcohol, denatured, 188 proof	gal.	.....	.35 – .36
Alcohol, denatured, 190 proof	gal.	.....	.37 – .38
Alum, ammonia lump	lb.	.03½ – .03¾	.04 – .04½
Alum, potash lump	lb.	.03½ – .04	.04 – .04½
Alum, chrome lump	lb.	.10 – .11	.11 – .12½
Aluminum sulphate, commercial	lb.	.02 – .02½	.02½ – .02¾
Aluminum sulphate, iron free	lb.	.03 – .03½	.03½ – .04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	.07½ – .07¾	.08 – .08½
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	.30 – .32	.33 – .35
Ammonium carbonate, powder	lb.	.07 – .07½	.08 – .09
Ammonium chloride, granular (white salammoniac)	lb.	.06 – .06½	.06½ – .07½
Ammonium chloride, granular (gray salammoniac)	lb.	.07 – .07½	.07½ – .08
Ammonium nitrate	lb.	.07 – .07½	.07½ – .08½
Ammonium sulphate	100 lb.	2.20 – 2.25	2.30 – 2.40
Amylacetate	gal.	.....	3.25 – 3.50
Amylacetate tech	gal.	.....	2.50 – 3.00
Arsenic oxide, (white arsenic) powdered	lb.	.06½ – .06¾	.07 – .07½
Arsenic, sulphide, powdered (red arsenic)	lb.	.11 – .11½	.12 – .13
Barium chloride	ton	48.00 – 50.00	51.00 – 53.00
Barium dioxide (peroxide)	lb.	.20 – .21	.22 – .23
Barium nitrate	lb.	.08 – .08½	.08½ – .09½
Barium sulphate (precip.) (blanc fixe)	lb.	.04 – .04½	.04½ – .05½
Bleaching powder (see calc. hypochlorite)		.....	.....
Blue vitriol (see copper sulphate)		.....	.....
Borax (see sodium borate)		.....	.....
Brimstone (see sulphur, roll)		.....	.....
Bromine	lb.	.27 – .28	.28½ – .30
Calcium acetate	100 lbs.	2.00 – 2.05	.....
Calcium carbide	lb.	.04½ – .04¾	.05 – .05½
Calcium chloride, fused, lump	ton	23.50 – 24.00	24.50 – 25.50
Calcium chloride, granulated	lb.	.01½ – .02	.02½ – .02¾
Calcium hypochlorite (bleach powder)	100 lb.	2.85 – 2.90	3.00 – 3.50
Calcium peroxide	lb.	.....	1.40 – 1.50
Calcium phosphate, tribasic	lb.	.....	.15 – .16
Camphor	lb.	.....	.73 – .75
Carbon bisulphide	lb.	.06 – .06½	.06½ – .07½
Carbon tetrachloride, drums	lb.	.10½ – .10¾	.11 – .12
Carbonyl chloride (phosgene)	lb.	.....	.60 – .75
Caustic potash (see potassium hydroxide)		.....	.....
Caustic soda (see sodium hydroxide)		.....	.....
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	.08 – .09	.09½ – .10
Chloroform	lb.	.....	.38 – .43
Cobalt oxide	lb.	.....	2.00 – 2.10
Copperas (see iron sulphate)		.....	.....
Copper carbonate, green precipitate	lb.	.19 – .19½	.20 – .21
Copper cyanide	lb.	.....	.50 – .62
Copper sulphate, crystals	lb.	.05½ – .05¾	.05½ – .06½
Cream of tartar (see potassium bitartrate)		.....	.....
Epsom salt (see magnesium sulphate)		.....	.....
Ethyl Acetate Com. 85%	gal.	.....	1.00 – 1.10
Ethyl Acetate pure (acetic ether 98% to 100%)	lb.	.....	.40 – .42
Formaldehyde, 40 per cent	lb.	.12½ – .12¾	.13 – .13½
Fusel oil, ref	gal.	.....	3.25 – 3.75
Fusel oil, crude	gal.	.....	1.50 – 1.75
Glauber's salt (see sodium sulphate)		.....	.....
Glycerine, C. P. drums extra	lb.	.....	.14 – .14½
Iodine, resublimed	lb.	.....	3.50 – 3.60
Iron oxide, red	lb.	.....	.10 – .20
Iron sulphate (copperas)	ton	18.00 – 19.00	20.00 – 21.00
Lead acetate	lb.	.....	.10½ – .12½
Lead arsenate, paste	lb.	.09 – .09½	.10 – .11
Lead nitrate	lb.	.....	.15 – .20
Litharge	lb.	.08½ – .09	.09½ – .09¾
Lithium carbonate	lb.	.....	1.30 – 1.40
Magnesium carbonate, technical	lb.	.09 – .09½	.10 – .11
Magnesium sulphate, U. S. P.	100 lb.	2.40 – 2.75	.....
Magnesium sulphate, technical	100 lb.	.....	1.05 – 1.60
Methanol, 95%	gal.	.....	.66 – .68
Methanol, 97%	gal.	.....	.70 – .72
Nickel salt, double	lb.	.....	.12 – .12½
Nickel salt, single	lb.	.....	.14 – .14½
Phosgene (see carbonyl chloride)		.....	.....
Phosphorus, red	lb.	.40 – .41	.42 – .45
Phosphorus, yellow	lb.	.....	.30 – .35
Potassium bichromate	lb.	.11½ – .11¾	.12 – .12½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	$ – $	$0.28½–$0.29½
Potassium bromide, granular	lb.	–	.16 – .25
Potassium carbonate, U. S. P.	lb.	.35 – .40	.45 – .50
Potassium carbonate, 80–85%	lb.	.05 – .05½	.06 – .06½
Potassium chlorate, crystals	lb.	.07 – .07½	.08 – .10
Potassium cyanide	lb	–	.26 – .28
Potassium hydroxide (caustic potash)	lb.	.04½ – .05	.05½ – .06
Potassium muriate, 80% K.C.l.	ton	42.50 – 45.00	–
Potassium iodide	lb.	–	2.75 – 3.00
Potassium nitrate	lb.	.09½ – .09½	.10 – .12½
Potassium permanganate	lb.	.25 – .26	.26½ – .27
Potassium prussiate, red	lb.	.28 – .29	.29½ – .30
Potassium prussiate, yellow	lb.	.20½ – .21	.22 – .22½
Potassium sulphate (powdered)	per unit	–	1.20 – 1.25
Rochelle salts (see sodium potas tartrate)		–	–
Salammoniac (see ammonium chloride)		–	–
Sal soda (see sodium carbonate)		–	–
Salt cake	ton	–	22.00 – 25.00
Silver cyanide	oz.	–	1.35 – 1.38
Silver nitrate	oz.	–	.41½ – .42
Soda ash, light	100 lb.	2.10 – 2.15	2.20 – 2.70
Soda ash, dense	100 lb.	2.35 – 2.40	2.45 – 2.70
Sodium acetate	lb.	.04½ – .04½	.04½ – .05½
Sodium bicarbonate	100 lb.	2.25 – 2.40	2.50 – 2.75
Sodium bichromate	lb.	.07½ – .08	.08½ – .08¾
Sodium bisulphate (nitre cake)	ton	5.00 – 5.25	5.50 – 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.04 – .05	.05½ – .06
Sodium borate (borax)	lb.	.05 – .06	.06 – .06½
Sodium carbonate (sal soda)	100 lb.	1.90 – 2.00	2.10 – 2.40
Sodium chlorate	lb.	.07½ – .07½	.08 – .08½
Sodium cyanide	lb.	.19½ – .21	.22 – .30
Sodium fluoride	lb.	.11 – .11½	.12 – .13
Sodium hydroxide (caustic soda)	100 lb.	3.85 – 3.90	3.95 – 4.60
Sodium hyposulphite		–	.03½ – .03½
Sodium nitrate	100 lb.	2.10 –	2.30 –
Sodium nitrite	lb.	.07 – .07	.07½ – .08
Sodium peroxide, powdered	lb.	.25 – .26	.27 – .30
Sodium phosphate, dibasic	lb.	.04½ – .04½	.05 – .05½
Sodium potassium tartrate (Rochelle salts)	lb.	–	.21 – .24
Sodium prussiate, yellow	lb.	.12 – .12½	.12½ – .13
Sodium silicate, solution (40 deg.)	100 lb.	1.00 – 1.15	1.25 – 1.40
Sodium silicate, solution (60 deg.)	lb.	.02½ – .03	.03½ – .03½
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 – 1.75	2.00 – 2.25
Sodium sulphide, fused, 60–62 per cent (conc.)	lb.	.04½ – .04½	.05 – .05½
Sodium sulphite, crystals	lb.	.03½ – .04	.04½ – .04½
Strontium nitrate, powdered	lb.	.12 – .12½	.13 – .14
Sulphur chloride, red	lb.	.05½ – .06	.06½ – .07
Sulphur, crude	ton	20.00 – 22.00	–
Sulphur dioxide, liquid, cylinders extra	lb.	.08 – .08½	.09 – .10
Sulphur (sublimed), flour	100 lb.	–	2.25 – 3.10
Sulphur, roll (brimstone)	100 lb.	–	2.00 – 2.75
Tin bichloride, 50 per cent	lb.	.18 – .19	–
Tin oxide	lb.	–	.38 – .40
Zinc carbonate, precipitate	lb.	.15½ – .16	.16 – .17
Zinc chloride, gran	lb.	.11 – .11½	.11½ – .12
Zinc cyanide	lb.	.42 – .44	.45 – .47
Zinc dust	lb.	.11½ – .11½	.11½ – .12½
Zinc oxide, XX	lb.	.07½ – .07¾	.08 – .09
Zinc sulphate	100 lb.	3.00 – 3.25	3.30 – 3.50

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	$1.10 — $1.15
Alpha-naphthol, refined	lb.	1.25 — 1.30
Alpha-naphthylamine	lb.	.35 — .40
Aniline oil, drums extra	lb.	.18 — .21
Aniline salts	lb.	.25 — .28
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.25
Benzidine, base	lb.	1.00 — 1.10
Benzidine sulphate	lb	.75 — .85
Benzoic acid, U.S.P.	lb.	.60 — .65
Benzoate of soda, U.S.P.	lb.	.55 — .60
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 — .28
Benzyl chloride, 95-97%, refined	lb.	.25 — .27
Benzyl chloride, tech	lb.	.20 — .23
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech	lb.	.32 — .35
Beta-naphthyla mine, sublimed	lb.	1.75 — 1.80
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 — .27
Cresylic acid, 97–99%, straw color, in drums	gal.	.68 — .75
Cresylic acid, 95-97%, dark, in drums	gal.	.65 — .70
Cresylic acid, 50%, first quality, drums	gal.	.45 — .50
Dichlorbenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.25
Dimethylaniline	lb.	.45 — .55
Dinitrobenzene	lb.	.26 — .28
Dinitroclorbenzene	lb.	.20 — .30
Dinitronaphthalene	lb.	.30 — .40
Dinitrophenol	lb.	.35 — .40
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, car lots, in drums	gal.	.40 — .45
Diphenylamine	lb.	.65 — .70
H-acid	lb.	1.15 — 1.25
Meta-phenylenediamine	lb.	1.15 — 1.20
Monochlorbenzene	lb.	.12 — .14
Monoethylaniline	lb.	1.75 — 1.85
Naphthalene crushed, in bbls.	lb.	.06½ — .07½
Naphthalene, flake	lb.	.06½ — .08
Naphthalene, balls	lb.	.08 — .09½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.16 — .18
Ortho-amidophenol	lb.	3.10 — 3.20
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.80 — .85
Ortho-nitro-toluene	lb.	.15 — .20
Ortho-toluidine	lb.	.20 — .25
Para-amidophenol, base	lb.	1.40 — 1.45
Para-amidophenol, HCl	lb.	1.60 — 1.75
Para-dichlorbenzene	lb.	.15 — .20
Paranitroaniline	lb.	.75 — .80
Para-nitrotoluene	lb.	.85 — .95
Para-phenylenediamine	lb.	1.70 — 1.75
Para-toluidine	lb.	1.25 — 1.40
Phthalic anhydride	lb.	.50 — .60
Phenol, U. S. P., drums	lb.	.09½ — .11
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.60 — 1.65
Resorcinol, pure	lb.	2.25 — 2.30
Salicylic acid, tech., in bbls.	lb.	.19 — .22
Salicylic acid, U. S. P.	lb.	.20 — .25
Salol	lb.	.60 — .75
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 — .16
Sulphanilic acid, crude	lb.	.27 — .30
Tolidine	lb.	1.25 — 1.35
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.25 — .28
Toluene, in drums	gal.	.28 — .31
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.40 — .45
Xylene, pure, in tank cars	gal.	.45 — –
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — –

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	$0.24 — $0.25
Beeswax, refined, light	lb.	.28 — .30
Beeswax, white pure	lb.	.36 — .42
Candelilla wax	lb.	.25 — .26
Carnauba, Flors	lb.	.48 — .50
Carnauba, No. 2, North Country	lb.	.25 — .26
Carnauba, No. 3, North Country	lb.	.15 — .16
Japan	lb.	.20½ — .21½
Montan, crude	lb.	.06½ — .06½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 —
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p.	lb.	.03½ — .03½
Paraffine waxes, refined, 128-130 m.p.	lb.	.03½ — .04½
Paraffine waxes, refined, 133-135 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ — .06
Stearic acid, single pressed	lb.	.09½ — –
Stearic acid, double pressed	lb.	.10 —
Stearic acid, triple pressed	lb.	.11 — .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	$5.25 —	5.30
Rosin E-I	280 lb.	5.30 —	5.40
Rosin K-N	280 lb.	5.55 —	5.70
Rosin W. G.-W. W	280 lb.	6.60 —	7.35
Wood rosin, bbl	280 lb.	6.25 —	–
Spirits of turpentine	gal.	.65 —	–
Wood turpentine steam dist	gal.	.63 —	–
Wood turpentine, dest. dist.	gal.	.61 —	–
Pine tar pitch, bbl	200 lb.	– —	7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	– —	11.50
Retort tar, bbl.	500 lb.	– —	11.50
Rosin oil, first run	gal.	.35 —	–
Rosin oil, second run	gal.	.37 —	–
Rosin oil, third run	gal.	.41 —	–
Pine oil, steam dist., sp.gr., 0.930-0.940	gal.		$1.90
Pine oil, pure, dest. dist	gal.		1.50
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.		.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.		.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.		.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.		.35
Turpentine, crude, sp. gr., 0.900-0.970	gal.		1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990	gal.		.35
Pinewood creosote, ref	gal.		.52

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	$0.37
70-72 deg., steel bbls. (85 lb.)	gal.	.35
68-70 deg., steel bbls. (85 lb.)	gal.	.34
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.23

Crude Rubber

Para—Upriver fine	lb.	$0.16 —	.17
Upriver coarse	lb.	.09 —	.09½
Upriver caucho ball	lb.	.11½ —	.12
Plantation—First latex crepe	lb.	.14 —	–
Ribbed smoked sheets	lb.	.12 —	.12½
Brown crepe, thin, clean	lb.	.15 —	–
Amber crepe No. 1	lb.	.17 —	–

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	$0.09½ —	$0.09½
Castor oil, AA, in bbls.	lb.	.10½ —	.11
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.12 —	.12½
Cocoanut oil, Ceylon grade, in bbls.	lb.	.10 —	.10½
Cocoanut oil, Cochin grade, in bbls.	lb.	.10½ —	.11½
Corn oil, crude, in bbls.	lb.	.08½ —	.08¾
Cottonseed oil, crude (f. o. b. mill)	lb.	.06½ —	.06½
Cottonseed oil, summer yellow	lb.	.08½ —	.09
Cottonseed oil, winter yellow	lb.	.09½ —	–
Linseed oil, raw, car lots (domestic)	gal.	.73 —	.74
Linseed oil, raw, tank cars (domestic)	gal.	.67 —	.68
Linseed oil, in 5-bbl lots (domestic)	gal.	.75 —	.76

Olive oil, Denatured	gal.	$1.10 —	$1.20
Palm, Lagos	lb.	.07 —	.07½
Palm, Niger	lb.	.05½ —	.06
Peanut oil, crude, tank cars (f.o.b. mill)	lb.	.07½ —	.07¾
Peanut oil, refined, in bbls	lb.	.10½ —	.10¾
Rapeseed oil, refined in bbls	gal.	.86 —	.88
Rapeseed oil, blown, in bbls	gal.	.92 —	.94
Soya bean oil (Manchurian), in bbls. N. Y	lb.	.08½ —	....
Soya bean oil, tank cars, f.o.b., Pacific coast	lb.	.06½ —	....
FISH			
Light pressed menhaden	gal.	$0.40 —	....
Yellow bleached menhaden	gal.	.42 —	....
White bleached menhaden	gal.	.44 —	....
Blown menhaden	gal.	.48 —	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	$24.00 —	30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00 —	26.00
Barytes, crude, 88%@94% ba., Kings Creek	net ton	10.00 —	12.00
Barytes, floated, f.o.b. St. Louis	net ton	26.50 —	28.00
Barytes, crude, first grade, Missouri	net ton	7.00 —	....
Blanc fixe, dry	lb.	.04 —	.04½
Blanc fixe, pulp	net ton	45.00 —	55.00
Casein	lb.	.06½ —	.07½
Chalk, Precipitated, domestic, extra light	lb.	.04½ —	.05
Chalk, Precipitated, domestic, light	lb.	.04 —	.04½
Chalk, Precipitated, domestic, heavy	lb.	.03½ —	.04
Chalk, Precipitated, English, extra light	lb.	.04½ —	.05
Chalk, Precipitated, English, light	lb.	.04½ —	.05
Chalk, Precipitated, English, dense	lb.	.04 —	.04½
China clay (kaolin) crude, f.o.b. mines, Georgia	net ton	6.50 —	8.50
China clay (kaolin) washed, f.o.b. Georgia	net ton	9.00 —	10.00
China clay (kaolin) powdered, f.o.b. Georgia	net ton	13.00 —	20.00
China clay (kaolin) crude f.o.b. Virginia points	net ton	8.00 —	12.00
China clay (kaolin) ground, f.o.b. Virginia points	net ton	13.00 —	20.00
China clay (kaolin), imported, lump	net ton	12.00 —	20.00
China clay (kaolin), imported, powdered	net ton	25.00 —	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points	net ton	5.00 —	7.50
Feldspar, crude, f.o.b. Maine	net ton	7.50 —	10.00
Feldspar, ground, f.o.b. Maine	net ton	21.00 —	23.00
Feldspar, ground, f.o.b. North Carolina	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. N. Y. State	net ton	17.00 —	21.00
Feldspar, ground, f.o.b. Baltimore	net ton	27.00 —	30.00
Fullers earth, f.o.b. Mines	net ton	16.00 —	17.00
Fullers earth, granular, f.o.b. Pa	net ton	15.00 —	18.00
Fullers earth, powdered, f.o.b. Fla	net ton	18.00 —	....
Fullers earth, imported, powdered	net ton	24.00 —	27.00
Graphite, Ceylon lump, first quality	lb.	.06 —	.07
Graphite, Ceylon chip	lb.	.04½ —	.05
Graphite, high grade amorphous crude	lb.	.00½ —	.02½
Magnesite, calcined	per ton	66.00 —	70.00
Pumice stone, imported, lump	lb.	.03 —	.40
Pumice stone, domestic lump	lb.	.05 —	.05½
Pumice stone, ground	lb.	.06 —	.07
Quartz (acid tower) first to head, f.o.b. Baltimore	net ton	.... —	10.00
Quartz (acid tower) 1½@2 in., f.o.b. Baltimore	net ton	.... —	14.00
Quartz (acid tower) rice, f.o.b. Baltimore	net ton	.... —	17.00
Quartz, lump, f.o.b. North Carolina	net ton	5.00 —	7.50
Shellac, orange fine	lb.	.52 —	.53
Shellac, orange superfine	lb.	.55 —	.56
Shellac, A. C. garnet	lb.	.44 —	.45
Shellac, T. N.	lb.	.45 —	.46
Soapstone	ton	12.00 —	15.00
Sodium chloride	long ton	12.50 —	13.00
Talc, paper-making grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, roofing grades, f.o.b. Vermont	ton	8.50 —	13.00
Talc, rubber grades, f.o.b. Vermont	ton	11.00 —	18.00
Talc, powdered, Southern, f.o.b. cars	ton	10.00 —	14.00
Talc, imported	ton	30.00 —	40.00
Talc, California talcum powder grade	ton	18.00 —	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh	per ton	$37.50–40.00	
Carborundum refractory brick, 9-in.	less than carlot	1,000	1250.00
	carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points	net ton	60	....
Chrome cement, 40–45% Cr_2O_3	net ton	30–	32
Chrome cement, 40–45% Cr_2O_3, sacks, in car lots, f.o.b. Eastern shipping points	net ton	33–	35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	36–	40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works	1,000	30–	35
Magnesite brick, 9-in. straight	net ton		70
Magnesite brick, 9-in. arches, wedges and keys	net ton		77
Magnesite brick, soaps and splits	net ton		98
Silica brick, 9-in. sizes, f.o.b. Chicago district	1,000	42–	45
Silica brick, 9-in. sizes, f.o.b. Birmingham district	1,000	46–	50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa	1,000	35–	38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y	net ton	$200.00 —	$225.00
Ferrochrome per lb. of Cr. contained, 6–8% carbon, carlots	lb.	.12 —	....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots	lb.	.13 —	....
Ferromanganese, 76-80% Mn, domestic	net ton	65.00 —	67.00
Ferromanganese, 76-80% Mn, English	net ton	65.00 —	67.00
Spiegeleisen, 18-22% Mn	net ton	25.00 —	27.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo	lb.	2.50 —	....
Ferrosilicon, 10-15%	net ton	40.00 —	42.00
Ferrosilicon, 50%	net ton	65.00 —	68.00
Ferrosilicon, 75%	e. ton	135.00 —	138.00
Ferrotungsten, 70-80%, per lb. of contained W	lb.	.40 —	.45
Ferrouranium, 35-50% of U, per lb. of U content	lb.	6.00 —	....
Ferrovanadium, 30-40% per lb. of contained V	lb.	4.25 —	4.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content	net ton	$8.00 —	$10.00
Chrome ore, Calif. concentrates, 50% min. Cr_2O_3	unit	.30 —	.33
Chrome ore, 50% Cr_2O_3, f.o.b. Atlantic seaboard	unit	30 —	.33
Coke, foundry, f.o.b. ovens	net ton	4.25 —	4.50
Coke, furnace, f.o.b. ovens	net ton	3.00 —	3.25
Coke, petroleum, refinery, Atlantic seaboard	net ton	14.00 —	15.00
Fluorspar, lump, f.o.b. mines, New Mexico	net ton	12.50 —	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines	net ton	20.00 —	22.00
Ilmenite, 52% TiO_2, per lb. ore	lb.	.01½ —	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport	unit	.22 —	....
Manganese ore, chemical (MnO_2)	net ton	50.00 —	55.00
Molybdenite, 85% MoS_2, per lb. of MoS_2, N. Y.	lb.	.55 —	.60
Monazite, per unit of ThO_2, c.i.f., Atlantic seaport	unit	30.00 —	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport	unit	.12 —	.12
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport	unit	.12 —	.12
Pyrites, domestic, fines, f.o.b. mines, Ga	unit	.11 —	.12
Rutile, 95% TiO_2 per lb. ore	lb.	.15 —	....
Tungsten, scheelite, 60% WO_3 and over, per unit of WO_3 (nominal)	unit	2.75 —	3.00
Tungsten, Wolframite, 60% WO_3 and over, per unit of WO_3, N. Y. C	unit	3.00 —	3.25
Uranium ore (carnotite) per lb. of U_3O_8	lb.	1.50 —	2.50
Uranium oxide, 96% per lb. contained U_3O_8	lb.	2.25 —	2.50
Vanadium pentoxide, 99%	lb.	12.00 —	14.00
Vanadium ore, per lb. of V_2O_5 contained	lb.	1.00 —	....
Zircon, washed, iron free	lb.	.03 —	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic	12.00@12.25
Aluminum, 98 to 99 per cent	24.5@25
Antimony, wholesale lots, Chinese and Japanese	4¼@4½
Nickel, ordinary (ingot)	41.00
Nickel, electrolytic	44.00
Monel metal, spot and blocks	35.00
Monel metal ingots	38.00
Monel metal, sheet bars	40.00
Tin, 5-ton lots, Straits	27.00
Lead, New York, spot	4.40
Lead, E. St. Louis, spot	4.20@4.25
Zinc, spot, New York	4.50@4.55
Zinc, spot, E. St. Louis	4.15@4.20

OTHER METALS

Silver (commercial)	oz.	$0.62½
Cadmium	lb.	1.00–1.25
Bismuth (500 lb. lots)	lb.	1.50@1.55
Cobalt	lb.	3.00@3.25
Magnesium (f.o.b. Philadelphia)	lb.	1.25
Platinum	oz.	75.00@78.00
Iridium	oz.	160.00@170.00
Palladium	oz.	55.00–60.00
Mercury	75 lb.	43.50–45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled	19.75@20.00
Copper bottoms	27.25@27.50
Copper rods	18.50@19.00
High brass wire	16.75
High brass rods	13.75
Low brass wire	18.25
Low brass rods	18.25
Brazed brass tubing	27.00
Brazed bronze tubing	31.75
Seamless copper tubing	20.00
Seamless high brass tubing	18.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible	9.00@9.25	9.25	9.50
Copper, heavy and wire	8.25@8.50	8.50	8.50
Copper, light and bottoms	7.00@7.25	7.50	7.25
Lead, heavy	3.00@3.25	3.25	3.25
Lead, tea	2.25@2.35	2.25	2.25
Brass, heavy	4.00@4.25	4.50	5.00
Brass, light	3.00@3.25	3.25	3.50
No. 1 yellow brass turnings	3.75@4.00	4.25	4.50
Zinc	2.00@2.25	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ¼ in. and larger, and plates ¼ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes	$2.18	$3.00	$3.00
Soft steel bars	2.18	2.80	2.80
Soft steel bar shapes	2.18	2.90	2.90
Soft steel bands	2.50	3.20	3.20
Plates, ¼ to 1 in. thick	2.18	3.00	3.00

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Birmingham Flour Mills, 803 American Trust Bldg., have awarded a contract to Earl Cline, 1205 North 17th St., for the construction of its proposed new flour mill, 50 x 150 ft., to be equipped for a daily output of about 1,000 bbl. J. O. Walker is president.

Connecticut

BRIDGEPORT, CONN.—Arrangements are being perfected for a merger between the Raybestos Co., with local plant, and the General Asbestos & Rubber Co., Charleston, S. C., under the last noted name. Both companies specialize in the manufacture of textile asbestos products, including brake linings, etc., and the assets of the consolidated company will total $9 615,000. In addition to its Bridgeport works, the Raybestos Co. also maintains plants at Stratford, Conn., and Peterboro, Ont. The new company will continue the operation of these different factories. C. Bissell Jenkins will be chairman of the board of directors of the new organization, and Sumner Simpson, president.

Delaware

MILTON—The Edgewater Flour Mills have been acquired by Wilson & Hazzard. The new owners will make a number of improvements in the plant and place the mill in operation at an early date.

Florida

JACKSONVILLE—The Tidewater Glass Co., recently organized with a capital of $1,150,000, has acquired local property for the erection of a new plant for the manufacture of commercial glassware products, as milk bottles, jars, etc., utilizing local sand in connection with production. Two plant units will be constructed at the present time, estimated to cost about $300,000, with daily output of about two carloads of material. The equipment installation will include glass furnaces, tanks, annealing ovens, air compressors and other power equipment, mold shops, and with department for box manufacture. The new company is headed by C. H. Dankworth, Bellaire, O., and F. W. Stewart, Pittsburgh, Pa. Local offices are care of B. R. Kessler, secretary Jacksonville Chamber of Commerce, who has been instrumental in securing a site for the new company.

MIAMI—The Hector Supply Co. has acquired a local building, formerly used by the Southern Utilities Co., and will remodel the structure for a new plant for the manufacture of fertilizer products.

JACKSONVILLE—William W. Sheppard and Harry Whittier, both of Jacksonville, are organizing a new company, capitalized at $3,000,000, for the establishment of a new oil-refining and gasoline plant. The initial capacity will be about 2,000 bbl. of crude oil and 20,000 gal. of gasoline per day.

TAMPA—The Southern Bottle Mfg. Co., recently organized with a capital of $1,500,000, has completed plans for the erection of its proposed new local plant, to be 60 x 150 ft. Construction will be commenced at an early date. I. F. Jones is president and R. L. Rundell secretary.

Georgia

MONTICELLO—The Farmers' Milling Co., recently organized, is planning for the construction of a new flour mill on local site, with initial daily output of about 60 bbl.

COLUMBUS—The Armour Fertilizer Co., 209 West Jackson Blvd., Chicago, Ill., is reported to be planning for the rebuilding of its fertilizer works at Columbus, destroyed by fire, Aug. 9, with loss estimated at close to $300,000.

Louisiana

NEW ORLEANS—The Louisiana Colotex Co. has commenced production at its new local mills, recently completed at a cost of $500,000. The plant will be devoted to the manufacture of special board products made from bagasse, the refuse from sugar cane. The new plant is the first of a number of such mills the company proposes to construct in different parts of the state.

Maryland

BALTIMORE—The Cooknut Corp., Lexington and Paca Sts., Baltimore, has completed pans for its proposed new 4-story plant on Canton St., 88 x 100 ft., for the manufacture of lard substitutes and kindred products. It is estimated to cost $125,000. Erection will be commenced at an early date. W. R. Spruill is head.

WESTPORT — The Spanish American Cork Products Co., recently organized with a capital of $500,000, is planning for the establishment of a large plant at Westportman, for the manufacture of cork products. The company is headed by Walter V. Harrison and Philip S. Ball, Westport.

BALTIMORE—The Maryland Vegetable Oil Co., recently organized with a capital of $1,000,000, will take over an existing local plant, recently completed at a cost said to be over $500,000, for the manufacture of refined cottonseed oil and other oil products. Operations will be commenced at an early date. Enos Stockbridge and Roland H. Brady, Baltimore, head the company.

Massachusetts

CHELSEA—Fire, Aug. 23, destroyed a portion of the plant of the United Indigo & Chemical Co., with loss estimated at about $125,000.

HAVERHILL—The Bay State Brick & Stone Co., recently organized with a capital of $200,000, has construction under way on a new plant on the local river front for the manufacture of brick; it is proposed to make the plant one of the largest in this section. The company has acquired the plant and property of the Auburn Brick Co., West Auburn, Mass., and will remove the equipment to the new Haverhill works. George L. Baldwin, formerly manager of the Auburn plant, is president.

Michigan

GRAND RAPIDS—The Cross-Kramer Oil Co., recently organized with a capital of $50,000, and now operating an oil-compounding plant at Chicago, Ill., is considering the establishment of a similar plant at Grand Rapids. Richard A. Cross is president, and Fred W. Kramer secretary.

Missouri

CAPE GIRARDEAU — The National Silica Mining Co. is planning for the development and operation of silica properties in this section. Plans for the proposed plant are being prepared by G. E. Doane, consulting engineer, Poplar Bluff, Mo.

New Jersey

[redacted]

CAMDEN—The Lutz Co., Thirty-first St. and Grays Ferry Ave., Philadelphia, Pa., manufacturer of castings, machinery, etc., has commenced the erection of a 1-story addition to its foundry, 80 x 120 ft., on Hayes Ave. William Lutz is president.

New York

[redacted]

MECHANICSVILLE — Fire, Aug. 22, caused by a boiler explosion destroyed a portion of the plant of the West Virginia Pulp & Paper Co., including boiler department, equipped with a battery of three high-pressure boilers. The amount of estimated loss has not been announced.

NEW YORK—The Sinclair & Valentine Co., 21 St. Clair Pl., manufacturer of lithographing inks has commenced excavations for its proposed new 3-story plant on Broadway, between 129th and 130th Sts. The Lustbader Co., 423 Madison Ave., has the building contract.

TONAWANDA—The J. Spaulding & Sons Co., Wheeler St., manufacturer of fiber products, has construction under way on its new plant addition, consisting of a number of buildings estimated to cost about $125,000. The company plans for early occupancy and will increase its present working force from 175 to about 400 operatives as soon as the extensions are ready for service.

Ohio

GARRETTSVILLE—The McWade Rubber Co. has broken ground for the erection of a 2-story plant addition, 48 x 130 ft. The P. L. Frank Construction Co., Garrettsville, has the building contract.

DAYTON—The Refiners Oil Co., 315 South Main St., has awarded a contract to Frank Hill Smith, Inc., Winters National Bank, for the erection of a new 1-story works building on South Ludlow St., 100 x 144 ft. to cost about $40,000.

COVENTRY—The Palmer Match Co., ninth floor, Second National Bank Bldg., Akron, O., recently organized, has preliminary plans under way for the erection of its proposed new match-manufacturing plant at Coventry, near Kenmore, estimated to cost close to $1,000,000. Charles H. Palmer is president.

Oklahoma

TULSA—The Producers & Refiners Corp., is planning for the construction of a new oil refinery on local site, to utilize crude oil from the Salt Creek field.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., Ontario St. and Preble Ave., manufacturer of burned clay sanitary wares, has filed plans for the construction of a 1-story works addition to cost about $15,000.

PHILADELPHIA — The General Smelting Co., Stock Exchange Bldg., has taken bids for the erection of a new 1-story plant at Bath and Westmoreland Sts. Emile G. Parrot, 328 South Broad St., is architect.

PHILADELPHIA—The Atlantic Refining Co., Passyunk Ave., is reported to have plans under way for the rebuilding of the portion of its local refinery, destroyed by fire Aug. 14, with loss estimated at close to $1,000,000. The loss included a number of large tanks, 3 pumping plants, works buildings, etc.

Rhode Island

EAST GREENWICH — The Warwick Chemical Co., recently organized with a capital of $50,000, is planning for the establishment of a local plant for the manufacture of dyes and affiliated products. The company is headed by Samuel A. Olevson, Arctic, R. I., and John J. Clarke, West Warwick, R. I.

South Carolina

PROSPERITY—The Prosperity Oil Mill Co. is considering plans for the construction of a new flour mill on a local site. Estimates of cost and details of equipment installation are being arranged.

West Virginia

NITRO—The Viscose Co. of America, Marcus Hook, Pa., has acquired a portion of the former powder works of the Government at Nitro, comprising Area E, totaling about 52 acres of land, with a number of large buildings. Three of the structures will be used by the new owner for the manufacture of pulp from cotton linters, to be utilized at its artificial silk mills at Marcus Hook and Roanoke, Va. Work has been commenced on an addition to this latter plant to cost about $1,000,000.

Texas

WAXAHACHIE—The Texas Oil Products Co. has construction under way on a new local oil-refining plant, estimated to cost about $750,000.

MEXIA—The Golden State Refining Co. has acquired a local site and plans for the erection of a new oil refinery with initial output of about 6,000 bbl. a day.

New Companies

THE NOBLE COLOR WORKS, INC., Brooklyn, N. Y., has been incorporated with a capital of $25,000, to manufacture colors, paints, inks, etc. The incorporators are P. Conforti and V. Malvani. The company is represented by Collin, Wells & Hughes, 120 Broadway.

THE WESTERN METAL PRODUCTS CORP., Joliet, Ill., has been incorporated with a capital of $50,000, to manufacture metal goods. The incorporators are Alan A. Bakewell, Walter B. Stewart and Frederick A. Hill, 314 Barber Bldg.

THE HENRYETTE GLASS & MFG. CO., Henryette, Okla., has been incorporated with a capital of $50,000, to manufacture glass products. The incorporators are J. Ballson and H. L. Chambers, Henryette.

BEETLE-BARNES-BAKER, INC., Lynn, Mass., has been incorporated with a capital of $30,000, to manufacture waxes, rubber cement and kindred products. Lorenz F. Muther is president and William R. Beetle, 362 Massachusetts Ave., treasurer.

THE ASBESTOS MATERIALS CORP., New York, N. Y., has been incorporated with a capital of $400,000, to manufacture asbestos products. The incorporators are H. L. Delatour, H. Kaufman and J. Steinbrink. The company is represented by M. Steinbrink, 215 Montague St., Brooklyn.

THE WRIGHTSMAN OIL CO., Jersey City, N. J., has been incorporated with a capital of 5,000 shares of stock, no par value, to manufacture refined oil products. The incorporators are Charles J. Skinner and John R. Turner. The company is represented by the Corporation Trust Co., 15 Exchange Pl.

THE ELITE CHEMICAL CO., Nashville, Tenn., has been incorporated with a capital of $10,000, to manufacture chemicals and chemical byproducts. The incorporators are E. B. Harper and Biscoe Griffith, Nashville.

THE CAMBRIDGE TANNING CO., Cambridge, Mass., has been incorporated with a capital of $100,000, to manufacture leather products. Rishton T. Bailey, Massachusetts Ave. and Tannery St., is president and treasurer; Joseph J. Hurley is secretary.

THE VELVET SPECIALTY CO., 4708 Hastings St., Detroit, Mich., has been incorporated with a capital of $25,000, to manufacture paints, oils, polishes, etc. The incorporators are Edward F. Callan, M. E. Jeynes and Thomas A. Jeynes, 5957 Stanton Ave.

THE SUPERIOR SMELTING & REFINING CO., Jersey City, N. J., has been organized under state laws to operate a metal smelting and refining plant. The company is headed by Godfrey A. Welter and Louis Friedman, 819 Jersey Ave.

THE FIBRE TIRE & RUBBER CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture fiber and rubber products of various kinds. The incorporators are M. N. Salamon, E. F. File and E. F. Stoeckle. The company is represented by C. Foley, 38 Park Row.

THE PRICE OIL CORP., Los Angeles, Cal., has been incorporated with a capital of $1,000,000, to manufacture refined petroleum products. The incorporators are Harry Hirsh, M. Kantor and C. A. Kleinman. The company is represented by Joseph Crail, Union Oil Bldg.

THE UNION RUBBER CO., Calais, Me., has been incorporated with a capital of $500,000, to manufacture rubber products. Charlotte L. Lello, Calais, is president and treasurer; Harold H. Murchte is secretary.

THE FRANK MILLER CO., New York, N. Y., has been incorporated with a capital of $100,000, to manufacture leather dressings, dyes and affiliated products. The incorporators are Frank C. Miller, S. G. Martin and G. V. Hart. The company is represented by E. A. Kenney, 120 Broadway.

THE INDUSTRIAL PETROLEUM CORP., 14 East Jackson Blvd., Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture petroleum products. The incorporators are Samuel J. Lombard, Abner R. Allison and Thomas P. Collins.

FRASER & CO., Trenton, N. J., have been incorporated with a capital of $50,000, to manufacture chemicals and chemical byproducts. The company is represented by Arthur W. Britton, 65 Cedar St., New York.

THE VERIBEST PRODUCTS, INC., New York, N. Y., has been incorporated with a capital of $20,000, to manufacture chemicals, oils and kindred products. The incorporators are J. E. Morrell, L. F. Ivorson and H. Grayer. The company is represented by J. C. Lewis, 247 Fifth Ave.

THE AVON MFG. CO., INC., Natick, Mass., has been incorporated with a capital of $25,000, to manufacture leather products. Lester F. Sargent is president and treasurer; Winfield Temple, High St., Westwood, Mass., is secretary.

THE PARAMOUNT DYESTUFF & CHEMICAL CO., Jersey City, N. J., has been incorporated with a capital of $100,000, to manufacture chemicals, dyes and affiliated products. The incorporators are Maurice M. Reinhard, Francis J. Kremin and Maxwell Tischler. The company is represented by William M. Rysdyk, 76 Montgomery St.

THE NON TOX CHEMICAL CORP., Washington, D. C., has been incorporated under Delaware laws with a capital of $300,000, to manufacture chemicals and chemical byproducts. The incorporators are Harry W. Bagby, Christie H. Fesler and Joseph J. Mawhinney, Washington. The company is represented by the Capitol Trust Co., Dover, Del.

THE B. ROBBINS CO., New York, N. Y., has been incorporated with a capital of $12,000, to manufacture chemicals, chemical byproducts, etc. The incorporators are B. Robbins, H. D. Naum and J. Cohen. The company is represented by L. H. Robinson, 2 Rector St.

THE EXOLINE PRODUCTS & REFINING CO., 1924 Washington Blvd., Chicago, Ill., has been incorporated with a capital of $200,000, to manufacture refined oils, gasoline, etc. The incorporators are D. M. Kelly, Henry F. Snyder and Frank Mooney.

THE SAND LIME PRODUCTS CO., Detroit, Mich., has been incorporated with a capital of $50,000, to manufacture bricks and other sand lime products and byproducts. The incorporators are John Wyman, Harry W. Gould and Theron C. Taylor, 2436 West Grand Blvd.

THE COMMUNITY CUT GLASS CORP., Buffalo, N. Y., has been incorporated with a capital of $100,000, to manufacture glass products. The incorporators are F. Schneider, J. H. Stoffel and F. J. O'Connor. Harding & Harding, attorneys, Buffalo, represent the company.

THE EMPIRE OIL CORP., Long Beach, Cal., has been incorporated with a capital of $350,000, to manufacture petroleum products. The incorporators are J. D. Hawk, E. E. Bean and Charles R. Lewis, Long Beach. The company is represented by Louis N. Whealton, 206 Marine Bank Bldg.

THE KENYON BRICK & TILE CO., Oklahoma City, Okla., has been incorporated with a capital of $125,000, to manufacture brick, tile and other burned clay products. The incorporators are W. A. Kenyon and David Oliver, Oklahoma City.

CARRIS & WATSON, INC., Newark, N. J., has been incorporated with a capital of $50,000, to manufacture paper products. The incorporators are Milton Carris, Robert Watson and A. E. Jock. The company is represented by Michael Silver, 790 Broad St.

THE ALEXANIAN HOOPOE MFG. CO., South Bend, Ind., has been incorporated with a capital of $10,000, to manufacture chemical products, cleaning compounds, etc. The incorporators are J. G. and M. G. Alexanian, South Bend.

THE DALFORD OIL REFINING CO., Wilmington, Del., has been incorporated with a capital of $100,000,000, to manufacture refined oil products. The company is represented by the Corporation Trust Co., du Pont Bldg., Wilmington.

THE SIMPICI-T FOLDING BOX CO., Pawtucket, R. I., has been incorporated with a capital of $25,000, to manufacture paper boxes and other containers. The incorporators are Daniel L. Baxter, Pawtucket; Howard R. Thayer, Cranston; and Hayward T. Parsons, Providence, R. I.

THE PEARL [redacted] PRODUCTS CORP., [redacted] N. Y., has been incorporated with a capital of $50,000, to manufacture paints, varnishes, etc. The incorporators are W. J. Cook, J. H. and J. K. Barry. The company is represented by William M. Rysdyk, 76 Montgomery St., Jersey City, N. J.

THE NEW ENGLAND REFINING CO., Providence, R. I., has been incorporated with a [redacted]

Capital Increases, Etc.

THE RADIUM LUMINOUS MATERIAL CORP., 58 Pine St., New York, N. Y., has filed notice of change of name to the United States Radium Corp.

THE CROWN OIL CO., Syracuse, N. Y., manufacturer of refined oils, has filed notice of increase in capital from $150,000 to $300,000.

THE CONTINENTAL CHEMICAL CORP., Watseka, Ill., has filed notice of increase in capital to $25,000.

THE MIDDLETOWN RUBBER CO., Middletown, N. Y., has filed notice of increase in capital from $1,000,000 to $2,000,000.

THE AUDUBON CHEMICAL CO., a Delaware corporation, has filed notice of organization to operate in New York, with a capital of $250,000. H. N. Bennett, 47 West Sixty-third St., New York, represents the company.

THE SCOBELL-MILLER CHEMICAL CO., Rochester, N. Y., has filed notice of change of name to the Scobell Chemical Co.

THE J. A. C. PRODUCTION CO., Danville, Ill., has filed notice of increase in capital from $50,000 to $400,000, at the same time changing its name to the Vermillion Oil Co.

THE UNIVERSAL TRANS-LEVER SPRING CO., Detroit, Mich., manufacturer of steel springs, etc., has filed notice of increase in capital from $75,000 to $250,000.

THE STANDARD DRUG & CHEMICAL CO., 817 North Ashland Ave., Chicago, Ill., has filed notice of increase in capital from $10,000 to $50,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its twenty-first annual meeting at St. Louis, Feb. 27 to March 2, 1922.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society are holding a joint meeting in New York, Sept. 6 to 10.

AMERICAN GAS ASSOCIATION will hold its third annual convention in the Congress and Auditorium Hotels, Chicago, the week of Nov. 7.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its annual winter meeting at Baltimore, Md., Dec. 6 to 9. Headquarters will be at the Southern Hotel and the sessions will be held in the Engineers' Club.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its fall meeting at Wilkes-Barre, Pa., Sept. 12 to 17.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN PEAT SOCIETY will hold its fifteenth annual convention at the Hotel Commodore, New York City, Sept. 7, 8 and 9.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY has discontinued meetings for the summer and will resume them in October.

SOCIETY OF INDUSTRIAL ENGINEERS will hold its fall meeting at Springfield, Mass., Oct. 5 to 7.

TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY will hold its fall convention with the American Pulp and Paper Mill Superintendents' Association, at Washington, Philadelphia, Spring Grove, York, York Haven, Pa., and Wilmington, Del., Oct. 18 to 20.

The following meetings are scheduled to be held in Rumford Hall, the Chemists' Club, New York: Oct. 7—American Chemical Society, regular meeting; Oct. 14—Société de Chimie Industrielle, regular meeting; Oct. 21—Society of Chemical Industry, Grasselli Medal; Nov. 11—American Chemical Society (in charge), Society of Chemical Industry, American Electrochemical Society, Société de Chimie Industrielle, joint meeting; Nov. 18—American Electrochemical Society, regular meeting; Dec. 2—Society of Chemical Industry, regular meeting; Dec. 9—American Chemical Society, regular meeting.